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By-Beaird, James H.
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To identify the parameters of creativity exhibited in products of sixth grade children, 25 subjects (12 girls and 13 boys) were asked to produce written, art, and mechanical objects and to write a description of the product indicating its use. Ten judges graded the relative creativity of the objects by comparing their similarity to an object considered to be standard. The resulting development of a judgmental space for each class was factor analyzed to determine factors of the creativity of the products. Students were administered a battery of personality tests and tests of cognitive characteristics. All of the creativity factors identified contained both personality and cognitive correlates. Factors identified for written products were novelty, flexibility, and openness to expression; factors for definition of the creativity of artistic objects were inventiveness and novelty; and the creativity of manipulative objects was characterized by the factor of novelty. Indications were that individuals who produced creative stories had a set of characteristics distinct from those of persons who produced the more creative art objects which also were distinct from those who produced the more creative manipulative objects. (RJ)

FINAL REPORT
Project No. 5/8091
Contract No. OE-5-10-030

DIMENSIONS OF CREATIVITY IN ELEMENTARY SCHOOL CHILDREN

by James H. Beaird

January, 1969

U. S. Department of
Health, Education, and Welfare
Office of Education
Bureau of Research

TEACHING RESEARCH
A Division of the Oregon State System
of Higher Education

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James H. Beaird

July, 1967

The research reported herein was performed pursuant to a contract with the Office of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinion stated do not, therefore, necessarily represent official Office of Education position or policy.

TEACHING RESEARCH
A Division of the Oregon State System of Higher Education

Monmouth, Oregon

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Introduction

The study of creativity has, over the past decade, been greatly expanded. Out of this expanded creativity has evolved a somewhat increased understanding of the nature of creativity and a vastly developed awareness of the potential role creative behaviors play in the learning behavior of children. While the educational community is currently expressing this awareness, relatively little curricular change has been evidenced.

Such a lack of change is probably the result of (1) insufficient knowledge of the precise nature of creative ability, (2) lack of knowledge of developmental characteristics of creative ability, (3) a shortage of specific instruments or methodologies for assessment of creative ability of children and, (4) insufficient knowledge of the precise relationship between a child's creative ability and specific instructional elements within the curriculum. While several writers (e.g., Torrance, Smith, and Taylor) have attempted to outline teaching strategies based on concepts of creativity, such efforts are premature and may, in fact, be predicated on yet-to-be validated assumptions about creativity.

The Nature of Creativity

Torrance (1965) aptly classified definitions of creativity into four general classes - those which focus on the person, those which focus on the process, those which focus on the product, and those defined in terms of the situation. This study was an attempt to identify more clearly the nature of evolving creative behavior. The project was

based on the assumption that creativity must be studied within the context of the productions of individuals.

To completely appreciate the totality of the concept of creativity, all four classes must be considered since at a given point in time creativity is a process engaged in by a person operating in a situation, with an end result being a product. Studies of creativity to date have tended to emphasize one of these classes but inevitably have involved two or more classes. For example, MacKinnon's (1962) primary emphasis was on personal characteristics of persons judged to be highly creative; however, identification of his samples required careful consideration of the productions of these men. Likewise, studies of process cannot be conducted independently of the situation in which the process is used.

This study was based upon two assumptions. First, that creativity or the potential for creative behavior is present in all persons. Casual observation and recent emerging longitudinal evidence indicate that creative behavior in most individuals becomes truncated with age. There are rare exceptions to this, i.e., some individuals seem to persist in their striving for individuality (c.f. Freudian or Neo-Freudian theories) or self-actualization (c.f. Rogerian or Maslowian theories) thus overcoming the constraints on creativity presented by society. That some individuals do seemingly overcome these constraints is an enticing invitation to study what it is about them that permits such strength. On the other hand, other approaches might be more fruitful from a research standpoint and certainly from a practical application point of view.

Two alternative strategies to enhance creative behavior can be developed based upon significant research accomplished to date.

Based upon research of Guilford and, to some extent, of Maltzman (1961), creativity can be considered largely to be a cognitive function and, as such, strengthened through training and reinforcement. Maltzman reported that subjects given training in problem solving significantly improved their performance on tests of originality. Similar strategies developed by Torrance (1965) and Smith (1966) are also based on this conceptualization.

The MacKinnon (1962), Cattell (1959), and Drevdahl (1959) studies suggest an alternative strategy. If one accepts the premise that all individuals possess some potential for creative behavior one can argue that to enhance the potential requires the removal of inhibiting characteristics in the personality of the individual. While this strategy has not been tested extensively outside of psychoanalytic circles in clinical studies, pilot research by the author revealed some support for such a hypothesis. Using sixth grade children as subjects, a series of tests, commonly used as criteria for creativity (ideational fluency, flexibility, and word association) were administered. Subjects were divided into extreme groups of anxious and nonanxious subjects on the basis of their scores on the Children's Manifest Anxiety Scale (Palermo, et al., 1956). On all measures of creativity employed, non-anxious subjects scored significantly higher.

The present study was designed to contribute to the further understanding of creative behavior of elementary school age subject. It was predicated on the rationale that understanding of creative behavior requires the completion by persons of creative productions. Essentially, this was the model followed by MacKinnon and Cattell and is potentially a stronger model than others for understanding creative behavior because

the criterion is fixed by the model, i.e., something must be produced.

The problem of applying this model to younger children is that few, if any, have had an opportunity to produce creative output. This is in contrast to the scientists, architects, etc. studied by others. At the same time, productions by younger children that would meet criteria for creativity established by many, e.g., uniqueness, acceptance by peers, novel recombination of significant elements, occur so rarely as to preclude systematic and economical study of those who produced them. To accommodate these constraints this study required all subjects to develop three classes of products and assumed that some creativity would be present in all such productions. Judgments of relative creativity were made which then became the criteria for creativity in this study.

The criterion problem has plagued many studies of creative behavior to date. Taylor (1964) and Torrance (1965) have identified the criterion problem as the single most distressing problem facing creativity research to date. Many studies fail to use any external criteria thus defining creative behavior in terms of the test battery employed. Other studies have employed external criteria but have quanitifed the observations by using ratings of creativity by judges, superiors or peers. The latter often fall into the trap of resorting to a single rating to describe a very complex behavior. If judgments of creativity are to be utilized as the criterion for creative behavior, it follows that such judgments must describe the behavior along more than a single dimension. Such judgments may be collected in a variety of ways depending upon the rationale of the study and the specificity of knowledge relative to the behavior being judged. If the parameters of the behavior are well-documented, the judgmental process can

well be responses to checklist-type descriptions of the parameters, each of which is then treated independently. On the other hand, judgments must be permitted greater freedom when relatively little agreement is available regarding the nature of the behavior or when the study is essentially an exploratory one attempting to identify the nature of the beast.

The latter concerns were paramount in this study. It was posited that creative behavior is a multidimensional phenomenon viewed differently by judges representing various backgrounds and likely to differ from one type of endeavor to another. The judgmental process employed was the multidimensional scaling procedures (MDS) developed and described by Torgerson (1958). This technique introduces a minimum amount of investigator bias into the judgments of the sample of respondents, a characteristic which is desirable but which becomes experimentally cumbersome as the number of objects being judged increases. The procedure is described more fully in a later section of this report and in operational detail by Torgerson (1958).

This study was an attempt to identify the parameters of creativity exhibited in various products of sixth grade children. Specifically, the study had three major objectives each of which contributes to a final description of the nature of creative talents of the target population expressed in terms of various personality and cognitive traits of such children. The three major objectives were:

1. To identify the dimensionality of three classes of creative products (written, artistic, and manipulative) furnished by a group of sixth grade children,

2. To determine the relationships between the identified dimensions of each class of product and those personality factors measured by the

Children's Personality Questionnaire (CPQ) (Porter and Cattell, 1959), and,

3. To determine the relationships between the identified dimensions of each class of product and several cognitive traits measured by tests included in the ETS kit of reference tests for cognitive factors (French, Ekstrom, and Price, 1963).

The first of these objectives constituted the major investigative activity of this study, requiring the subjects to engage in activities leading to development of the products studied and the collection and analysis of independent judgments of the creativity exhibited in the products. Accomplishment of this objective resulted in the identification of the number of parameters required to account for the dimensionality of each type of product.

Once the dimensionality has been so identified, steps were taken to interpret or label each parameter. The latter two objectives were addressed towards this interpretation.

Identifying Dimensions of Creativity

As outlined previously, a major focus of this study was directed towards the identification of dimensions of creativity exhibited by the elementary school children. This phase of study required (1) collection of objects produced by the subjects and (2) an analysis of these objects such that the dimensionality could be ascertained.

Subjects were all members of a single sixth grade class enrolled in the Campus Elementary School, Oregon College of Education, during the 1963-1964 school year. Thirty subjects were initially enrolled in the study. Absences on testing and "production" days reduced the final sample to twenty-five subjects.

The twenty-five subjects comprising the sample for final analysis were almost equally divided between the sexes (12 girls and 13 boys). All subjects were enrolled in the sixth grade for the first time, although two subjects had repeated a previous grade and were, therefore, one year over age.

Collection of Objects

Three classes of objects were produced by the subjects. These classes: written objects, art objects, and mechanical (manipulative) objects, were chosen to represent three of the major areas in which creative endeavor is normally observed in school settings. All objects were produced within the context of actual classroom work with the exception of the latter, which was produced in a controlled laboratory setting apart from the classroom. Each class is described in detail below.

Written Objects. As part of the regular Language Arts portion of the curriculum, all subjects were instructed to write a short story entitled

"A Walk in the Woods." The topic was selected because of (1) its relevance to the locale of the subjects' environment and (2) its relative neutrality. The assignment was made during the Language Arts period on Monday morning of the third week of school, and the entire one-hour period was devoted to its completion. Subjects were permitted to work on the story during free time later in the day, but were required to submit the story to the teacher before dismissal in the afternoon. The teacher provided no assistance in preparation of the story.

Each subject was assigned an identification number which was placed on his story following submission. Xerox copies of the stories were made and originals returned to the teacher for instructional purposes.

Art Objects. During the art period on the same day that subjects prepared their short stories, the teacher provided instruction in construction of dioramas. Instruction included use of materials, use of color, use of clay, etc. Several examples of dioramas were shown and subjects practiced preparation of a diorama.

The following day subjects were told that on Thursday and Friday of that week they would devote their art periods to construction of a diorama that would illustrate the short story written previously, and were instructed to bring to class any special materials (grass, foliage, etc.) they might wish to use in construction of their diorama. Shoe boxes were provided for all subjects.

All dioramas were completed and submitted to the teacher prior to dismissal on Friday. During the following week color photographs were made of all dioramas. Photographs were made under standard conditions of lighting, camera position, setting and background. All dioramas were returned to subjects following photographing.

Manipulative Objects. Manipulative objects were prepared by subjects from kits of materials provided for them in a controlled laboratory setting. Each kit contained the following materials:

1. 1 wood board, 3" x 4", 1/4" thick,
2. 4 wood strips, 3/4" x 4", 1/8" thick,
3. 4 wood dowels, 1/4" diameter,
4. 12" plastic medicine vial, 5/8" diameter, with plastic cap,
5. 6 3/4" brads,
6. 6 3/4" brass fasteners,
7. 1 string, 18" in length,
8. 2 cotton balls
9. 3 4" x 6" index cards,
10. 3 glass marbles,
11. 6 thumbtacks,
12. 2 rubber bands,
13. 2 cork stoppers
14. 1 insulated copper wire, 18" in length, and
15. 6 paper clips

In addition subjects were provided with a hammer and scissors and had available masking tape, scotch tape, single-edge razor blades, a stapler, and glue.

Subjects were brought to the laboratory setting in groups of six. They were instructed to use the materials provided in the kit in making some type object that would have utility. No examples were given. Utility was defined for them if they appeared not to understand the directions. Subjects were told they must complete their project within one hour. Following instructions, subjects adjourned to individual booths and

worked there. No interaction was permitted. When subjects completed their projects, they were asked to write a brief description of the product, indicating its use.

All objects were photographed in black and white under standard conditions of lighting, background and camera-object distance and position.

Analysis for Dimensionality

Researchers have long been aware of the fact that most psychological characteristics exhibited by humans are complex and require representation in more than a single dimension. Utilization of test batteries rather than a single instrument and comparisons of individuals in terms of their verbal or nonverbal abilities, personality factors, socio-economic background, etc., are illustrative of this awareness. Efforts to express a multidimensional (complex) characteristic in unidimensional (simple) terms inevitably results in loss of information -- imprecise explanation or understanding. In too many studies researchers have tried to reduce the concept of creativity to a single dimension hopefully represented by a single scale value, derived from a single observation, e.g., a test score or peer rating. This study attempted to avoid such an error.

Instead, the study utilized a methodology designed to reflect whatever dimensionality (i.e. complexity) might be inherent in the creativity exhibited in the productions supplied by the students in the sample, the assumption being that complexity would be present but its exact nature unknown. When we say we know or understand the complexity of a human characteristic we are essentially saying we can identify and define the major dimensions required to describe the characteristic. With this knowledge, assessment of the characteristic can proceed by independently quantifying each dimension of the characteristic. For example, school

achievement is assessed through independent measurement of such dimensions as reading, mathematics, study skills, language arts, etc.

Another startegy is required when the nature of the complexity is either unknown or not universally recognized. The strategy must be, at the same time, exploratory and definitive. Factor analysis methodology employs such a strategy and is suited to the nature of phenomena confronted within the behavioral sciences.

The factor analytic model is predicated on a concept of space. It assumes that the set of objects being studied can be represented as points in space. Given that space, the model provides for (1) identification of the minimum number of dimensions required to define the space and (2) the projections of each point in the space on each identified dimension. These projections, usually called factor loadings, are simple the quantitative scale values which indicate the amount of that characteristic defined by the dimension.

A necessary first step in any factor analysis study is the location of the points in the space. The points may represent any set of objects, e.g., persons, tests, schools, or works of art. Location of points in space requires a distance model, that is, points may be located through identification of their distances from all other points under consideration.

Many distance models are available for use. In education, factor analysis is most often associated with studies of multiple test batteries, each test in the battery being considered a point in the space. The distance model most often employed is based upon the intercorrelations of the tests in the battery, utilizing these correlations as cosines of reference ang'es in the following manner. Consider a hypothetical space as shown in Figure 1.

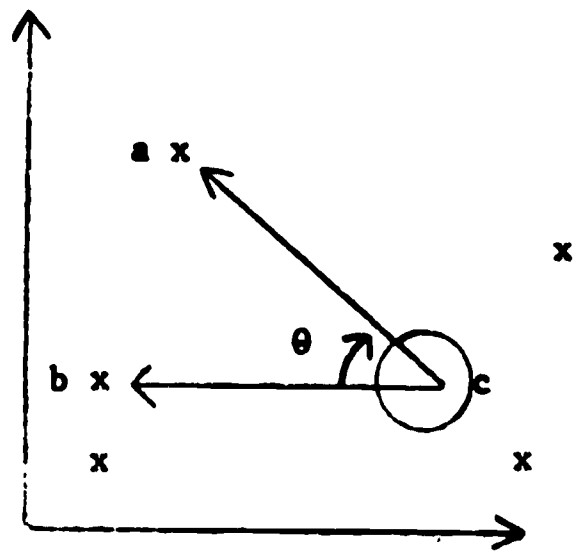

Figure 1. A Hypothetical Space in Two Dimensions

Considering c as a reference point in the space, the distance between a and b is a function of the cosine of $\angle \theta$. A matrix of all possible intercorrelations for a battery of tests thus permits the construction of a space defined by those points (tests) being employed.

This study, since it was not predicated on a battery of tests, employed another distance model, an extension of Thurstone's (1927) Law of Comparative Judgment (LCJ). The LCJ permits the translation of observer judgments to relative distances along a single continuum. Judgments are collected through presentation to a group of observers of all possible pairs of objects within a set and asking them to indicate which object of the pair has more of the characteristic being studied.

The multidimensional extension of the LCJ assumes that more than a single dimension may be necessary to account for interobject distances. Observer judgments are used; however, instead of asking the observers "which of these two objects has more of the characteristic," the extension asks "given these three objects, A, B, and C, is B or C most similar to A with respect to the characteristic." In this latter case, A is considered a standard and all comparisons of similarity are made in reference to the standard. The complete distance model requires that each object act, in

turn, as the standard. Judgments of similarity are translated to distances through the assumption that as objects are considered more dissimilar the distance between the objects is greater. The translation process involves several steps which are briefly identified in Appendix A.

The combination of a distance model and a spatial model results in a multidimensional scaling model (MDS). The MDS model employed in this study combines the distance model based on triads (a triad being a set of three objects) and the principal-axis factor analysis spatial model. The objects which were scaled in this study were the three sets of products supplied by the sample of sixth grade children. The observers (judges) were ten faculty members at Oregon College of Education, representing the following specialization areas: psychology, education, art, music, humanities, and science.

Judgments were made during November and December, 1964. Judges spent approximately 40-50 hours reacting to the sets of stimuli. Each judge was given a packet of materials which included: (1) xerox copies of all written products, (2) color photographs of the dioramas, (3) black and white photographs of the manipulative objects, and (4) directions for making judgments. The directions and recording forms are shown in Appendix B.

Accommodations for Error

The factor analytic model is derived mathematically and is therefore effective to the extent that points in the space being analyzed are located without error. An error-free condition rarely obtains in behavioral science studies. As a result, the researcher must make a decision as to which dimensions (factors) are "real" and which are artifacts of the measurement error introduced through the distance model.

Aware of the measurement error inherent in the MDS procedure, Torgerson (1958) suggested that the researcher define the "largest characteristic roots" as real factors and consider all others as error roots. A characteristic root may be determined for each obtained factor by summing the squares of each of the loadings on that factor. The size of the characteristic root is an indication of the strength of the factor.

The problem is that of defining what is meant by a "large" characteristic root. A statistical solution to this problem was investigated by the author (Beaird, 1961; Stake, Beaird and Sjogren, 1962). A conclusion of that research was that by plotting all characteristic roots obtained from a factor analytic study, nonerror factors could be reasonably differentiated from error roots upon identification of the point of inflection in the plot. A hypothetical but typical plot of characteristic roots is shown in Figure 2.

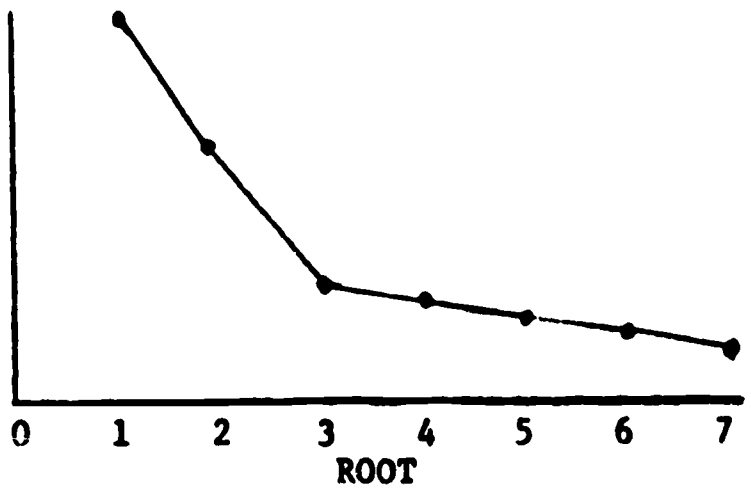

Figure 2. Hypothetical Plot of Characteristic Roots

The point of inflection of this plot occurs at root 3. Application of this strategy would suggest that all roots to the left of the point of inflection (Nos. 1 and 2) be defined as nonerror or real roots, with all others considered artifacts of error. This strategy was employed in this study.

MDS Results

MDS procedures were applied for each set of products (written, artistic, and manipulative) independently. The final step in this scaling process was the principal-axis factor analysis of the B* matrix (see Appendix A). This factor analysis procedure may be applied until (1) it has identified k-1 factors, where k is the order of the input matrix or (2) until a predetermined per cent of the total variation in the input matrix is accounted for. In this study, the latter alternative was used, the standard required being that ninety per cent of the total variation be accounted for.

The resulting factor matrices were then rotated to simple structure using the varimax procedure (Kaiser, 1958, 1959).

Written Objects. Application of MDS procedures to this set of objects resulted in the initial identification of 13 factors which accounted for 93.56 per cent of the variation in the input matrix. The obtained factor matrix is shown in Table 1.

Table 1

Principal-Axis Factor Loadings for Written Objects

Object	Factors I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	Communalities h^2
1	-1.78	.32	-1.29	-.75	-.96	.06	.30	.00	.76	-.12	-.58	-.05	.30	7.56
2	-1.10	.20	.07	1.02	.11	.06	-.32	.02	-.51	.50	1.05	.21	.66	5.11
3	-.45	-.61	-.47	.08	.55	.61	-.31	.59	-.27	-.04	-.65	.14	-.33	2.53
4	1.52	1.05	.22	.28	-.45	-.24	.14	.83	-.05	-.29	.24	.13	.16	4.67
5	.08	-.89	-.05	-.40	.54	-.41	-.17	-.18	1.17	.28	.49	.10	-.39	3.31
6	-.06	.37	.76	-.54	.84	-.28	.86	.19	-.06	-.15	-.08	-.48	-.59	3.50
7	-.62	.07	.78	-.03	.47	-.97	-.11	.04	.65	-.21	.49	-.66	-.15	3.80
8	-1.25	1.94	-.59	-.95	-.71	-.16	-.01	-.77	-.13	-.60	-.11	.03	.21	8.07
9	1.48	1.64	.42	-.44	-.58	-.89	.02	.88	.19	.33	-.41	.65	-.17	7.67
10	.10	-1.58	.93	.73	-.48	.00	-.18	.24	.69	.58	-.18	-.37	.36	4.71
11	-1.79	.10	.24	-.53	-.09	.36	.49	.62	-.32	.28	.24	.05	.09	5.15
12	-.65	-.01	.50	-.69	-.02	.63	-.71	-.21	-.56	-.00	.38	-.38	-.67	3.13
13	-1.83	1.62	-.20	1.46	-.01	-.19	-.25	-.07	-.36	.57	-.05	-.29	-.44	9.00
14	-.05	-.34	-.86	1.21	.28	-.07	.48	-.10	.29	-.61	-.21	-.35	.14	3.31
15	-.96	-1.60	.18	.24	.39	-.22	-.16	.26	-.43	-.84	.10	.35	.19	4.93
16	.72	-1.19	.19	-.92	-.95	.14	.07	.11	-.19	-.06	.44	-.33	.30	4.16
17	-.24	-.35	-1.20	-.27	.86	-.39	-.38	-.64	.12	1.08	-.57	.41	.04	4.80
18	2.43	.67	-.34	.32	-.57	-.03	-.73	-.67	-.07	.11	-.06	-.74	.17	8.41
19	.87	.22	-.24	.50	-.01	.54	-.45	1.16	-.14	.16	-.41	-.03	.19	3.13
20	.18	-1.52	.96	.34	-.71	-.38	-.36	-.37	.32	-.14	-.05	.43	-.13	4.62
21	.14	-.49	-1.26	.95	.47	-.30	.82	.02	-.06	-.55	.10	-.14	.25	4.20
22	.55	-.62	-1.12	-.72	.16	.14	-.03	.59	.05	-.14	.43	-.09	-.38	5.20
23	1.23	1.07	.69	.38	.22	1.68	1.13	-.58	.68	.16	.32	.52	-.03	8.58
24	-1.05	.45	.77	.40	.03	.20	-.97	-.31	.31	-.89	-.07	.83	-.16	4.67
25	2.10	.09	-.47	-.18	.37	-.02	-.29	-.59	-.58	-.36	-.15	.12	-.27	8.64
26	-.56	.48	.53	-.15	-.02	1.05	-.24	-.06	.09	.04	-.64	-.57	.07	3.76
27	.05	-1.24	-1.03	.12	-.90	-.14	.54	-.25	-.49	.53	.61	.41	-.51	5.11
28	.42	.02	.35	-1.23	1.19	-.12	-.18	-.20	-.23	.18	.14	.07	1.04	4.49
29	-.19	-.66	1.54	.47	-.22	-.65	1.00	-.55	-.97	.20	-.78	.04	.05	6.05
Characteristic Roots	36.84	26.12	16.16	13.50	8.99	8.20	7.55	6.93	6.18	5.62	5.29	4.31	3.91	

The plot of the characteristic roots is shown in Figure 3.

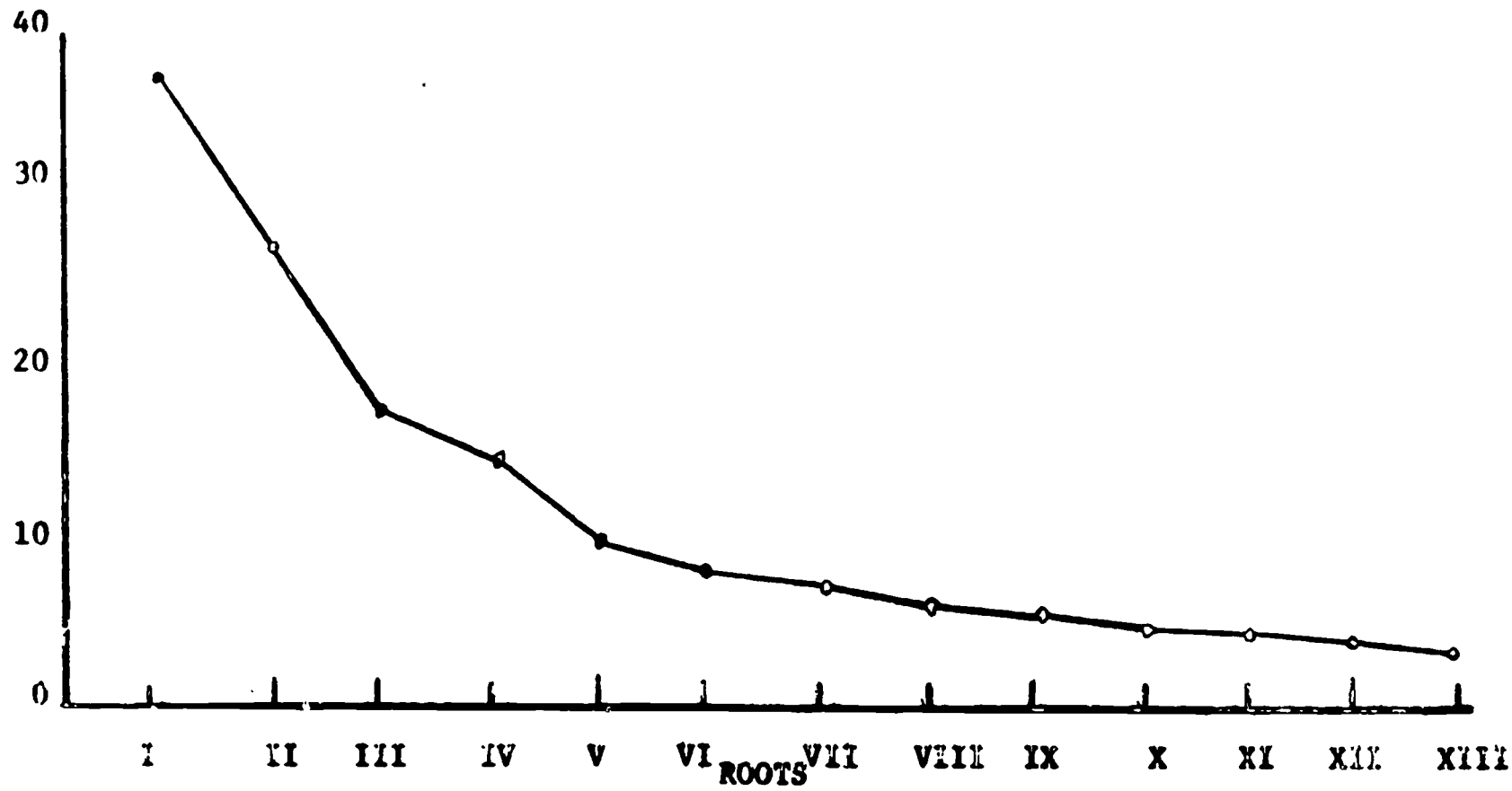

Figure 3. Plot of Characteristic roots of Principal-axis Factors for Written Objects

Applying the previously discussed strategy for identifying nonerror factors, it would appear that the critical point of inflection occurs at Root V. Therefore, we might infer the presence of four significant nonerror factors. These four factors accounted for 57.94 per cent of the total variation in the input matrix.

The obtained factor matrix was rotated to simple structure using varimax techniques. All 13 factors were utilized for the rotation. The resulting rotated factor matrix is shown in Table 2.

Table 2
Rotated Factor Loadings for Written Objects

	Factors												
Object	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
1	-1.33	-.03	2.12	.01	-.26	-.37	-.35	.47	.10	-.42	-.52	-.47	.24
2	-.54	2.04	-.03	.26	.08	.07	-.15	.45	-.11	.28	.23	.43	-.13
3	-.57	-.24	-.47	.16	-.23	-.34	-.51	-.04	-.27	-.67	-.18	-.66	-.70
4	.90	-.02	-.17	-1.48	-.03	.37	-.26	-.16	.14	.99	.04	.57	-.30
5	-.15	-.64	-.49	.34	.01	-.01	-.37	-.01	-.04	.59	.08	.21	1.41
6	-.24	-.06	.02	-.11	.18	.26	.31	-1.76	.14	.13	.25	.07	.12
7	-.14	.72	.21	-.05	.15	-.46	.13	-1.03	-.33	.46	.24	.10	1.22
8	-.20	.66	2.60	.08	.52	-.05	-.10	-.34	-.44	.17	.07	.34	-.31
9	.91	-.14	.24	-2.32	.72	.26	.06	-.60	.03	.15	.07	.90	-.05
10	-.14	-.16	-1.18	-.07	-.08	-.17	.74	.87	.24	.27	-.29	-.93	.94
11	-1.94	.29	.58	.36	.71	-.16	-.01	-.31	.26	.14	.13	-.18	-.23
12	-.13	.09	.01	.97	1.26	-.24	-.33	-.34	-.20	.23	-.14	-.35	-.27
13	-.44	2.58	.70	.01	-.70	-.27	.05	-.50	-.35	-.30	-1.01	-.16	-.24
14	.17	.22	-.05	.24	-1.72	-.06	-.12	.09	-.07	-.05	-.37	-.17	.01
15	-1.05	-.40	-.31	.93	-.59	-.97	.30	.39	-.73	.11	.21	.02	-.16
16	.08	-1.32	-.26	.32	.49	-.26	.10	.77	.83	.79	.15	.02	.10
17	.08	.09	.20	.23	-.15	-.29	-.22	.28	.31	-2.06	.33	.13	.14
18	2.69	-.20	.03	-.61	.07	.28	-.30	.40	.59	.36	.07	.01	-.11
19	.34	.08	-.65	-1.09	-.16	.01	-.71	.26	.13	.14	-.05	-.55	-.70
20	.05	-.75	-.92	.35	.20	-.35	1.01	.93	-.54	.23	-.46	-.04	.70
21	.12	-.05	-.16	.23	-1.90	-.07	-.27	.38	.34	-.16	-.09	.45	-.23
22	-.05	-1.00	-.16	.11	-.19	-.27	-1.24	.05	.57	-.19	-.03	.36	-.11
23	.58	.05	-.14	-.31	.00	2.80	-.00	-.30	-.06	.41	.06	-.12	-.14
24	-.33	.59	.21.	.21	.40	-.03	.11	.12	-1.96	.19	-.13	-.15	.12
25	2.35	-1.12	-.52	-.32	-.14	.42	-.34	-.13	.20	-.18	.44	.70	-.74
26	-.35	-.15	.09	.52	.34	.12	.16	.06	-.11	.05	-.02	-1.46	-.18
27	-.30	-.55	-.24	.72	-.24	-.14	.01	1.00	.96	-.35	-1.02	.96	-.20
28	.08	-.34	-.08	.07	.47	.05	-.02	-.31	.13	-.34	1.97	.11	.05
29	-.26	-.20	-.50	.23	.15	-.13	2.31	-.38	.13	.16	-.03	.02	-.26
Characteristic Roots	21.68	13.04	16.56	11.75	10.78	10.37	10.27	9.61	8.24	8.19	7.34	7.31	7.15

A plot of the characteristic roots obtained from the rotated factor matrix is shown in Figure 4.

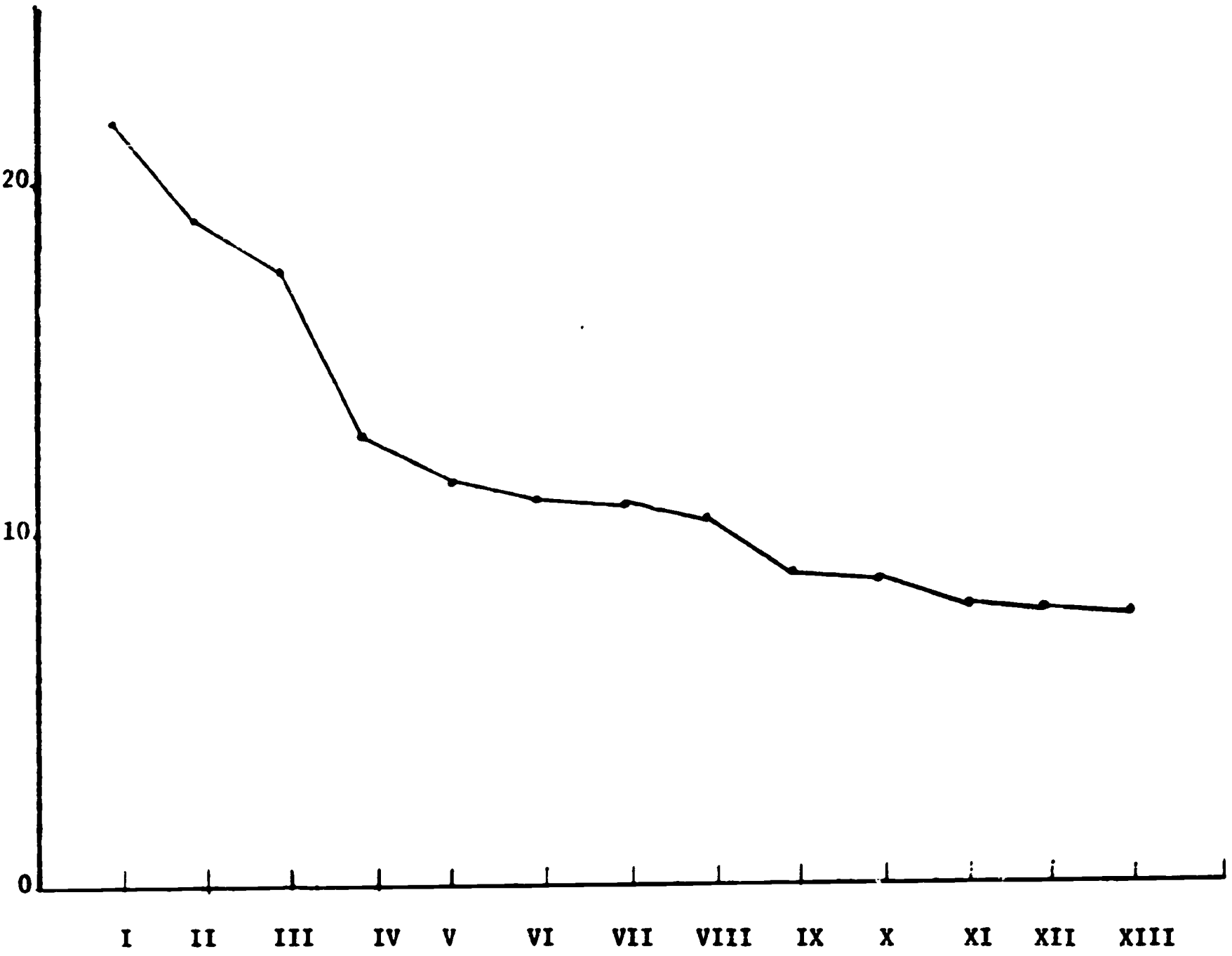

Figure 4. Plot of Characteristic Roots of Rotated Factors for Written Objects

It appears that the critical point of inflection occurs over Root IV. On this basis, Factors I, II, and III were considered nonerror factors and were utilized for succeeding phases of the study.

Artistic Objects. Completion of the MDS methodology for the dioramas resulted in the identification of five factors which accounted for 91.45 per cent of the variation within the input matrix. The obtained factor matrix is shown in Table 3.

Table 3
Principal-axis Factor Loadings for Artistic Objects

	Factors					
Object	I	II	III	IV	V	Communality h^2
1	1.53	.52	-.49	-.54	.37	3.28
2	2.71	1.18	-.06	.47	.83	9.64
3	3.28	1.34	.18	-.04	.95	13.69
4	-1.49	-.38	-.91	.53	-.27	3.54
5	-.24	-.72	-.27	-.06	-.51	.91
6	-1.76	-.38	-.98	.09	-.27	4.29
7	1.49	.02	-.28	-1.11	.01	3.53
8	-.96	-.42	-.39	.02	-.30	1.34
9	-1.59	.05	.34	.37	.03	2.79
10	1.20	-.93	1.56	.83	-.66	5.86
11	.21	-.53	-.19	1.28	-.38	2.14
12	1.30	-.65	.39	-1.25	-.46	4.03
13	3.47	1.66	.57	.52	1.17	16.66
14	1.72	.18	-.26	-.81	.13	3.74
15	-.35	-.49	-1.01	.68	-.34	1.96
16	-2.43	1.67	-.28	.09	1.18	10.17
17	-.81	-.28	-.17	-1.25	-.20	2.33
18	-1.77	.10	1.17	-.25	.07	4.57
19	-.06	-.60	-.22	1.33	-.42	2.36
20	-.25	-.73	-.17	-.46	-.51	1.09
21	.44	-.55	-.60	.50	-.39	1.25
22	-.63	-.37	.11	-.07	-.26	.62
23	-2.68	1.58	-.68	-.54	1.11	11.66
24	.17	-.98	.36	-.48	-.69	1.83
25	-3.21	1.37	1.63	.65	.96	16.18
26	.22	-.53	-1.08	.15	-.37	1.66
27	1.87	-1.13	1.38	.15	-.80	7.34
28	-2.21	-.16	1.23	-.87	-.11	7.19
29	.82	.17	-1.42	.06	.12	2.73
Characteristic Roots	86.74	20.15	18.28	13.08	10.05	

The plot of the characteristic roots is shown in Figure 5.

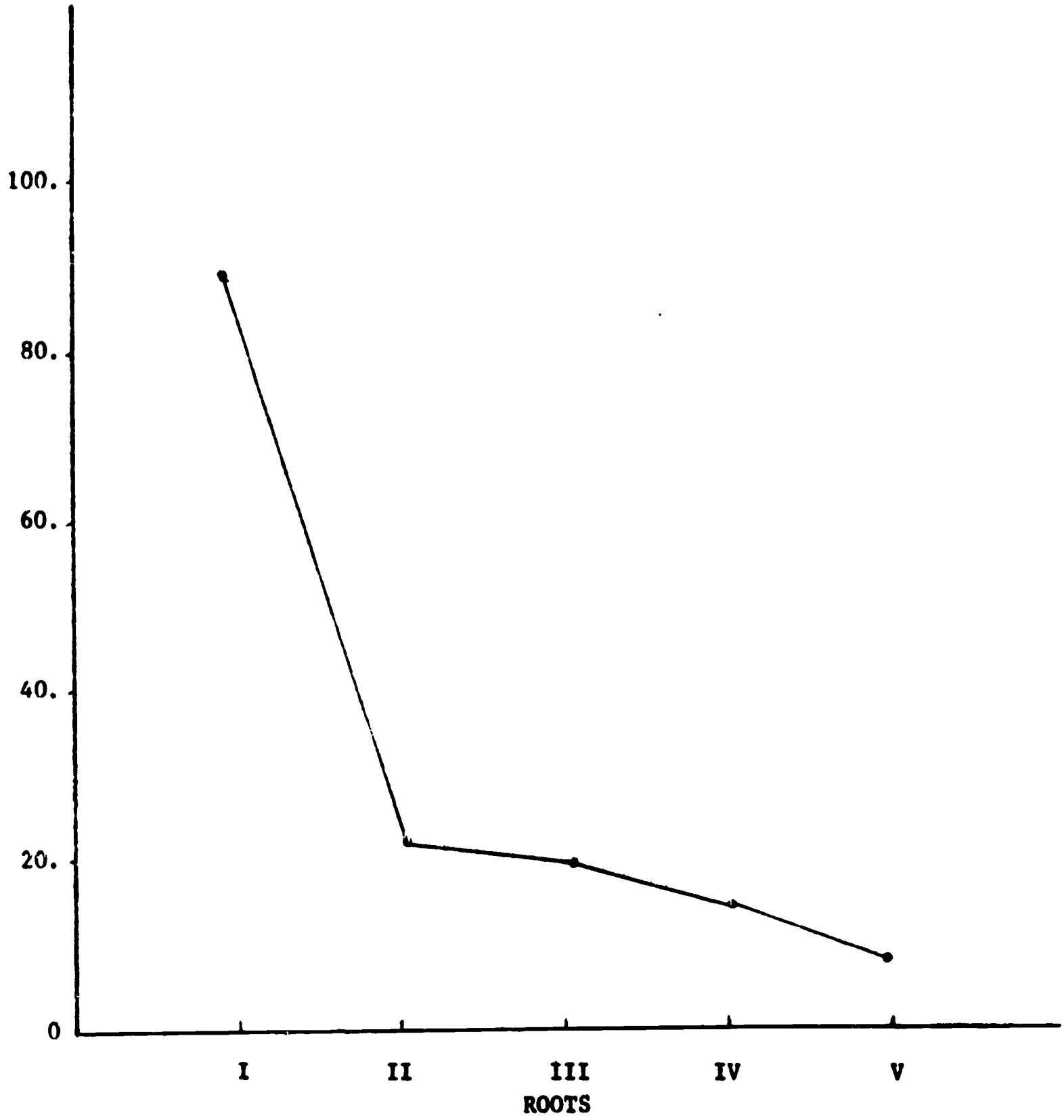

Figure 5. Plot of Characteristic Roots of Principal-axis Factors For Artistic Objects

It may be seen that the critical point of inflection in Figure 5 occurs at Root II. Thus it would appear that a single nonerror factor is present. This single factor accounted for 53.49 per cent of the total variation in this set of data.

The obtained factor matrix was rotated to simple structure. The rotated factor matrix is shown in Table 4.

Table 4
Rotated Factor Loadings for Artistic Objects

Objects	I	II	III	IV	V
1	1.12	-1.12	-.58	.39	.49
2	2.35	-1.19	.29	1.13	1.08
3	2.97	-1.28	-.20	1.07	-1.02
4	-1.78	-.05	.51	-.01	-.11
5	-.09	.24	.10	-.56	.51
6	-2.03	-.00	.08	-.15	.10
7	1.19	-1.03	-1.02	-.16	-.11
8	-1.04	.09	.07	-.26	-.36
9	-1.22	1.10	.30	-.04	.09
10	1.76	.64	1.08	-.59	-.59
11	.03	-.26	1.33	.09	.04
12	1.34	-.48	-.99	-.79	.74
13	3.33	-.96	.27	1.38	-1.18
14	1.39	-1.09	-.76	.06	-.19
15	-.84	-.71	.71	.06	.16
16	-2.18	1.21	-.37	1.00	.81
17	-.76	.15	-1.17	-.59	-.10
18	-.94	1.87	-.28	-.37	-.51
19	-.23	-.17	1.38	.05	-.38
20	-.31	-.15	-.30	-.60	-.91
21	.05	-.78	.59	-.05	-.01
22	-.50	.35	-.01	-.33	-.18
23	-2.58	.94	-.97	.81	.94
24	.31	.05	-.23	-.84	.71
25	-1.94	3.19	.26	.53	-.61
26	-.37	-1.08	.23	-.07	-.02
27	2.26	.09	.49	-.83	.73
28	-1.28	2.05	-.83	-.78	-.68
29	.01	-1.58	.01	.47	.83
Characteristic Roots	69.52	29.67	12.91	11.04	10.61

The plot of the obtained characteristic roots is shown in Figure 6.

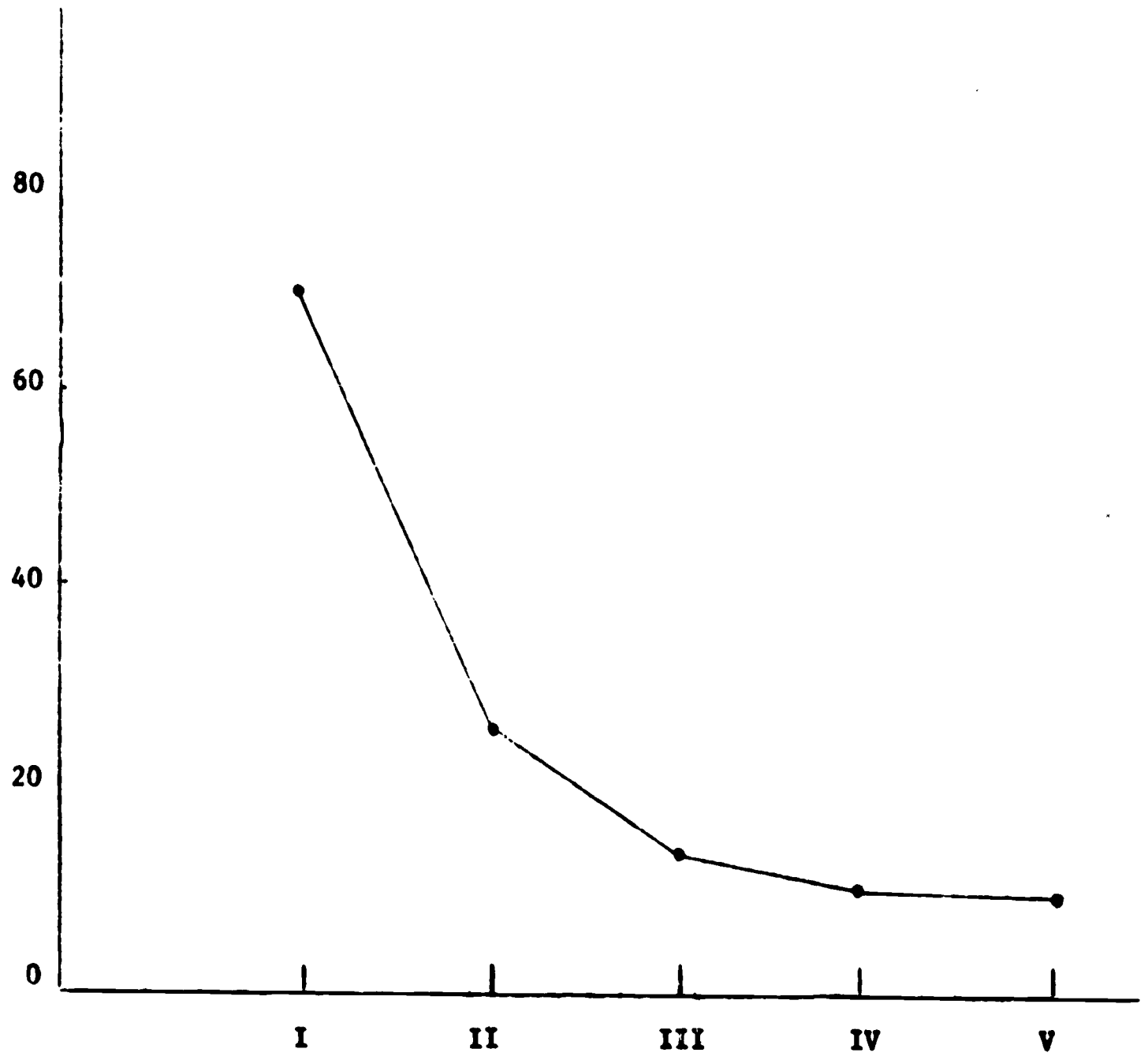

Figure 6. Plot of Characteristic Roots of Rotated Factors for Artistic Objects

The critical point of inflection appears to be at Root III. Therefore, Factors I and II were retained for further interpretation.

Manipulative Objects. The factor analysis phase of the MDS procedure identified nine factors which accounted for 97.67 per cent of the variation in the input matrix. The resulting factor loadings are shown in Table 5.

Table 5
Principal-axis Factor Loadings for Manipulative Objects

Object	Factors I	II	III	IV	V	VI	VII	VIII	IX	Communality h^2
1	-.82	-.03	-.01	-.30	-.13	.55	1.30	.40	.17	2.95
2	-.66	1.58	-.24	.44	-.66	-.65	.16	-.58	-.71	4.88
3	2.28	.06	-.31	1.39	-.41	-.20	-.37	.14	.12	7.62
4	1.14	-.63	.98	.11	.51	-.16	-1.06	.26	.04	4.16
5	-.72	-.16	-1.16	-.55	-.53	-.41	-.42	-.97	-.06	3.61
6	-.59	1.68	-.15	-.01	-.50	-.29	-.09	-.21	-.69	4.08
7	1.99	1.04	.02	-.35	.01	-.57	-.23	-.37	-.35	6.40
8	-1.05	-.76	.29	-.10	-.38	.93	-.12	-.62	.10	5.28
9	-1.75	.50	.46	.55	-.64	-.68	.14	-.21	-.21	4.90
10	-.07	.18	-1.14	-1.50	-1.10	.29	-.37	.06	.83	5.71
11	2.62	-.04	-.14	-.72	-.55	.29	-.15	.90	-.36	8.88
12	.29	-1.43	-.13	.12	-.07	-.97	.25	.60	-.45	3.57
13	2.07	.13	.14	-.77	.34	.77	.65	-.69	-.22	6.55
14	-1.24	-.22	-.56	.01	.06	.91	-.26	.77	-.62	3.80
15	.47	.89	-1.50	1.52	1.06	.54	.21	-.15	.49	7.34
16	-1.23	-.97	.12	.73	.27	.76	-.31	-.34	-.65	4.28
17	-1.07	.43	1.35	-.32	.15	-.21	.51	-.35	.60	3.88
18	.69	-.41	.71	-.45	.61	.06	-1.05	-.23	-.05	2.89
19	-.59	-.38	-.78	-.54	-.61	.10	-.19	.21	.92	2.82
20	-.99	.02	.10	-.91	.67	.13	.66	.81	-.33	3.46
21	1.15	-1.04	.15	.84	-.29	-.47	.65	-.46	.40	4.20
22	.60	1.65	-1.11	.40	1.02	.23	-.11	.25	.30	5.76
23	-.95	-1.28	-1.13	-1.03	1.61	-1.07	.15	-.45	-.15	8.88
24	.58	-1.36	.15	.54	-.34	-.14	.42	-.05	-.01	2.79
25	-.60	-.40	.36	.31	-.32	1.09	-.29	-.47	-.50	2.59
26	-.17	.87	1.45	-.43	.44	-.34	-.08	.46	.10	3.61
27	1.40	-.62	.54	.55	-.32	-.21	.67	.16	.21	3.61
28	-2.19	-.20	-.13	.95	-.17	-.54	-.63	.80	.43	7.29
29	-.49	.93	1.74	.02	.35	.24	-.03	-.21	.63	4.75
Characteristic Roots	44.49	21.58	17.81	14.94	10.55	8.92	7.31	6.81	5.80	

The plot of characteristic roots for this solution are shown in Figure 7.

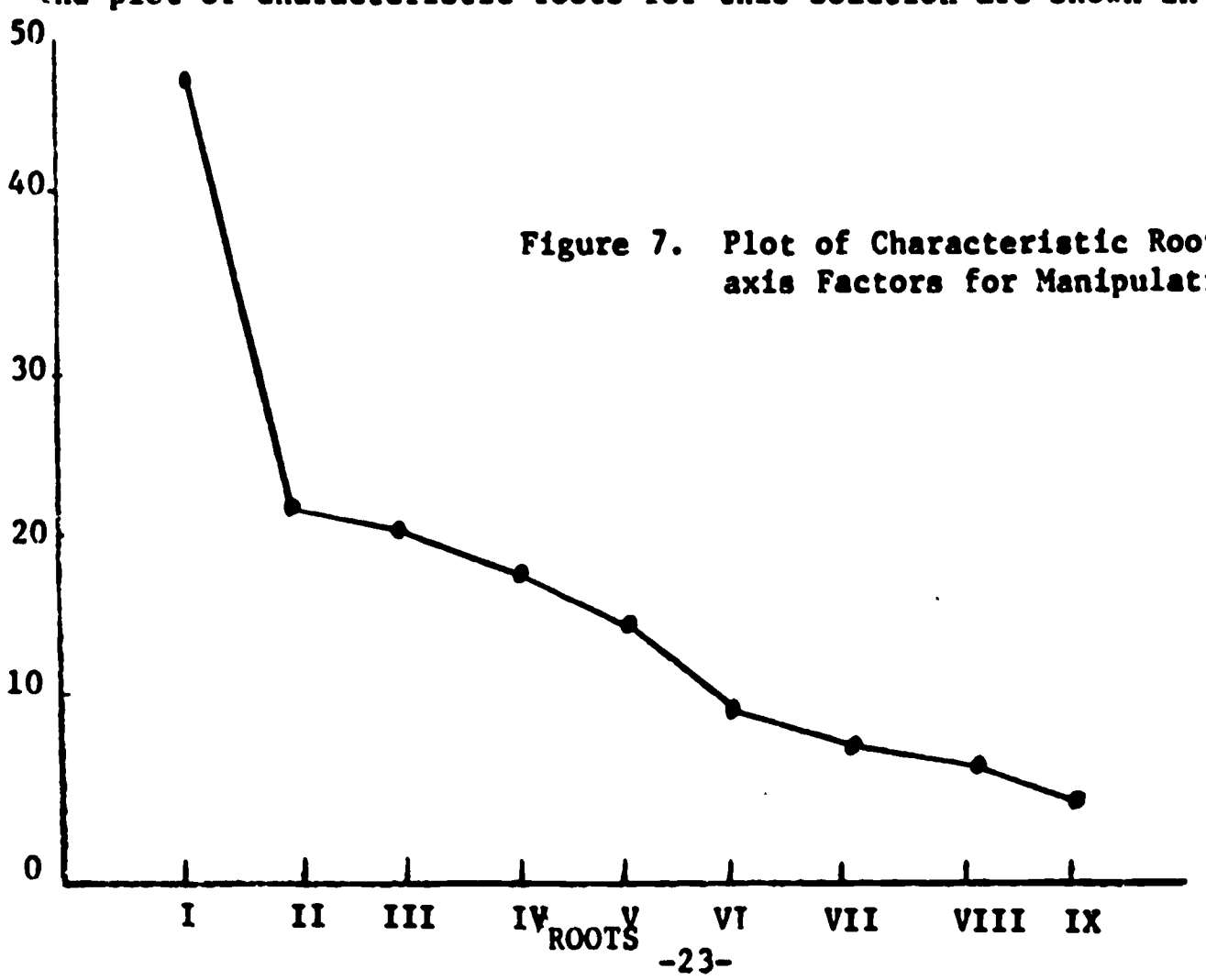

Figure 7. Plot of Characteristic Roots of Principal-axis Factors for Manipulative Objects

In Figure 7 the critical point of inflection appears to occur at Root II, suggesting the presence of one nonerror Factor.

The obtained factor matrix was rotated to simple structure. The resulting factor matrix is shown in Table 6.

Table 6
Rotated Factor Loadings for Manipulative Objects

	Factors								
Object	I	II	III	IV	V	VI	VII	VIII	IX
1	-.10	.28	.14	.27	.04	-.14	.03	.13	1.66
2	-.24	-.20	.41	.14	-2.12	.24	-.17	-.17	.02
3	.00	-.82	-1.36	-.96	.16	.82	-1.30	-.47	-1.09
4	.24	-.25	-.30	.19	1.16	-.37	-.31	-.62	-1.39
5	-.20	.34	.18	-.62	-.84	-.09	.31	1.19	-.26
6	-.16	-.46	1.04	.14	-1.54	.10	-.59	-.15	.29
7	1.82	-1.37	.08	-.07	-.41	-.04	-.24	-.08	-.97
8	-.52	1.33	-.03	.31	.12	-.36	.20	.49	.22
9	-1.49	.39	.15	.67	-1.37	-.45	.10	-.09	.35
10	.42	-.26	.58	-.38	-.03	-.24	-.12	2.21	.19
11	1.75	-1.17	-.20	-1.10	.83	-.50	-1.36	.06	-.50
12	-.40	-.39	-.77	-1.02	.59	-.93	.45	-.39	.07
13	2.45	-.21	-.43	-.08	.46	.21	-.15	-.24	-.08
14	-.90	.89	1.19	-.67	.24	.01	-.08	-.01	.65
15	-.05	-.23	.17	-.62	-.13	2.59	-.05	-.33	.15
16	-.87	1.73	.13	-.28	.18	-.04	.39	-.53	.05
17	-.42	.20	.13	1.90	-.24	-.42	.26	-.03	.32
18	.51	.08	.18	.33	.85	-.32	.18	-.23	-1.25
19	-.57	.09	.11	-.19	.24	-.06	.14	1.49	.37
20	-.22	-.13	1.09	.24	.58	-.48	.61	-.24	1.16
21	.26	-.16	-1.96	-.32	.32	-.02	-.06	-.25	-.13
22	.39	-.97	.90	-.17	-.45	1.97	-.15	-.15	-.06
23	-.42	-.13	.28	-.59	.56	-.17	2.80	.18	.13
24	-.03	.27	-1.35	-.57	.55	-.48	-.05	-.26	.06
25	-.06	1.56	.17	.00	-.04	-.15	-.30	-.14	-.03
26	-.02	-.62	.66	1.45	.06	-.47	-.26	-.63	-.12
27	.56	-.47	-1.45	-.15	.50	-.25	-.63	-.50	.04
28	-2.61	.35	.42	.18	-.21	.03	.10	.22	.20
29	-.09	.17	.28	2.07	-.06	.02	-.41	-.43	-.09
Characteristic Roots	25.28	17.34	16.34	16.01	14.44	14.11	13.41	11.27	10.86

The plot of the characteristic roots for the rotated factor matrix is shown in Figure 8.

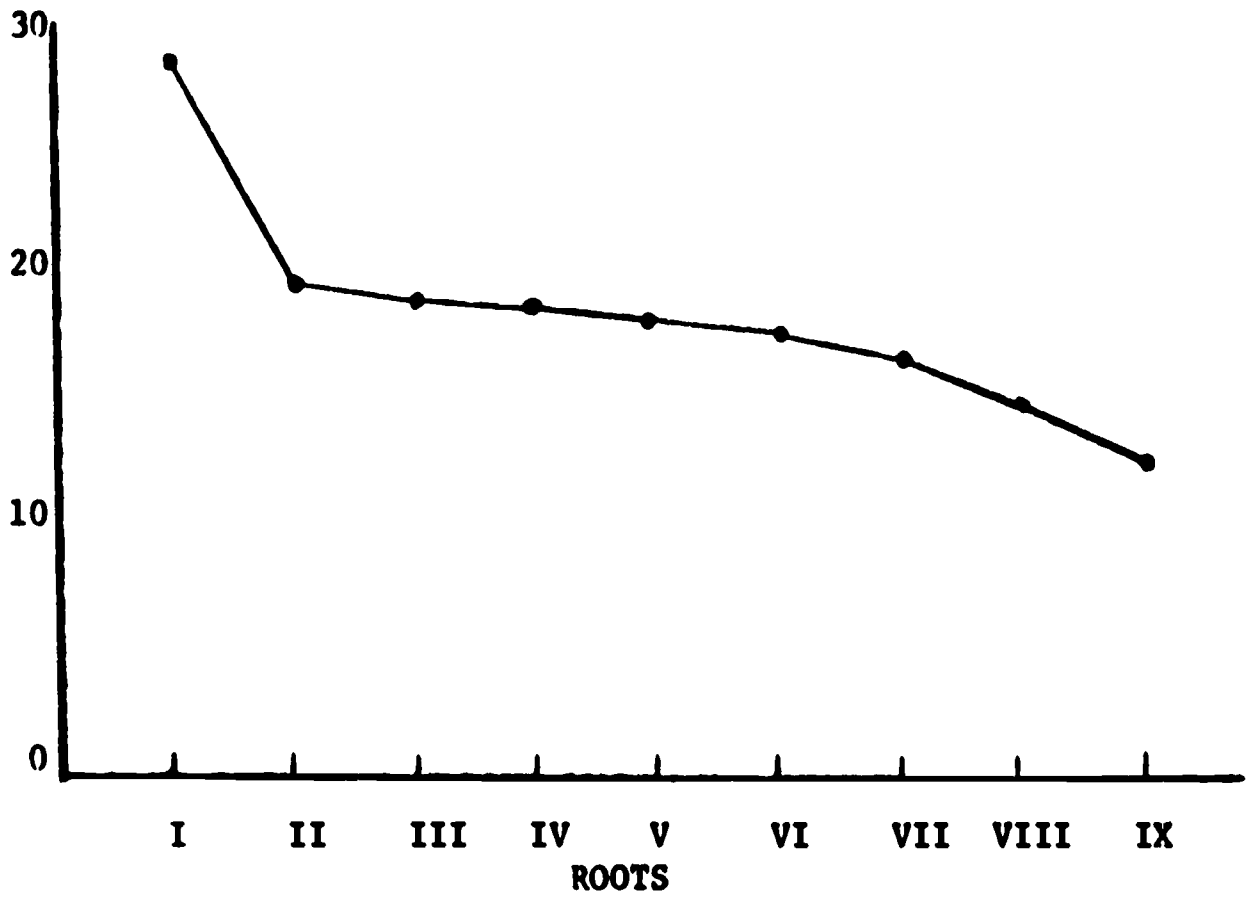

Figure 8. Plot of Characteristic Roots of Rotated Factors for Manipulative Objects

In Figure 8 it is observed that the critical point of inflection occurs at Root II. Therefore, only Factor I was considered for further analysis.

Summary. MDS Solutions were completed for the three classes of student products. Principal-axis factors analyses were rotated to simple structure using varimax rotation procedures. As a result of these analyses it was determined that: (1) three dimensions (factors) were required to define the creative "space" for written objects, (2) two dimensions were required for definition of creativity of artistic objects, and (3) the creativity exhibited in manipulative objects could be defined by a single dimension.

Relationship of Personality and Cognitive Characteristics to Identified Dimensions of Creativity

The sixth grade sample administered a battery of personality tests and tests of cognitive characteristics during the first month of the school year. Personality characteristics were measured using the Childrens Personality Questionnaire (CPQ) (Porter and Cattell, 1959) and the Childrens Manifest Anxiety Scale (CMAS) (Palermo, et al., 1956). Cognitive characteristics were measured with tests selected from the ETS Kit of Reference Tests for Cognitive Factors (French, et al., 1963). The tests were administered on seven separate days during a two week period. No more than one hour was devoted to testing during any one day.

Description of the tests used and scoring procedures employed for each are shown in Appendix C. The CPQ yielded scores on 14 personality traits. These 14 CPQ scores plus the CMAS score, thus combined to provide 15 personality measures. Three of the nine cognitive trait tests employed yielded two scores. Thus, 12 measures of cognitive traits were used in this study. Identification numbers for the 27 measures used are shown in Table 7.

Table 7

Identification Numbers of the Personality and Cognitive Measures Employed in the Study

Identification Number	Test Title
1	Cyclothymia
2	Mental Capacity
3	Ego Strength
4	Excitability
5	Dominance
6	Surgency
7	Super Ego Strength
8	Parmia
9	Premsia
10	Coasthenia
11	Shrewdness
12	Guilt Proneness
13	Self Sentiment
14	Ergic Tension
15	CMAS
16	Things Always
17	Prefixes
18	Suffixes
19	Beginnings and Endings
20	Word Association (Fluency)
21	Word Association (Classes)
22	Uses (Fluency)
23	Uses (Classes)
24	Ideas
25	Hidden Figures
26	Theme (Fluency)
27	Theme (Novelty)

Correlations of the observed trait measures with obtained Rotated Factor Loadings are shown in Table 8.

Table 8

Correlations of Personality and Cognitive Measures with Retained Factor Loadings

	Written			Artistic		Manipulative
Personality Measures	I	II	III	I	II	I
1	-.13	.07	.30	.31	-.11	.26
2	-.17	-.36	-.24	.18	-.32	.34
3	.17	-.26	-.50	.27	.04	.19
4	.43	-.05	-.04	.02	.08	-.29
5	.21	-.25	-.64	-.00	.16	-.13
6	.35	.02	-.33	-.09	.26	-.06
7	-.22	-.08	.28	.21	-.02	.24
8	.08	-.06	-.25	-.33	.28	-.03
9	-.24	.28	.42	.17	-.17	.23
10	.01	.54	.30	-.08	-.03	-.14
11	-.06	.20	-.19	.11	-.14	-.01
12	-.10	.29	.30	-.17	-.12	-.30
13	-.38	.03	.16	.20	-.17	.10
14	.06	.33	-.02	.16	-.34	-.13
15	.25	.12	.05	-.06	.05	-.14
Cognitive Measures						
16	-.47	-.13	-.10	.43	-.41	.38
17	-.21	-.05	-.22	.18	-.34	.02
18	-.58	.14	-.12	.38	-.50	.32
19	-.29	.18	-.02	.17	-.14	.30
20	-.27	-.03	-.18	.24	-.18	.25
21	-.30	-.05	-.17	.26	-.26	.27
22	-.35	.13	-.16	.19	-.29	.14
23	-.26	.18	-.12	.18	-.22	.18
24	-.29	-.15	.18	.23	-.34	.17
25	-.31	.04	.07	.09	-.26	.23
26	-.60	.08	-.07	.32	-.73	.35
27	-.27	-.29	-.06	.41	-.36	.33

In general these correlations are relatively small. Correlations of this magnitude should be expected, however, since many of the factor

loadings are low and cluster around zero. One or more correlations for each factor are, however, sufficiently high to be considered statistically significant ($p < .05$) for a sample of this size (d.f.=24).

Written Objects. Factor I was positively related to Excitability (.43) and negatively related to Self Sentiment (-.38), Things Always (-.47), Suffixes (-.58), and Theme (Fluency) (-.60), the latter three measures being cognitive traits. Factor II was positively related to Coasthenia (.54), a characteristic of those who prefer to act individualistically. Factor III was positively related to the measure of Parmia (.42) which characterizes friendly, gregarious, outgoing individuals. The Factor was negatively related to Ego Strength (-.50) and Dominance (-.64).

Artistic Objects. Both of the obtained Factors were significantly related to cognitive traits only, Factor I positively and Factor II negatively. Factor I was positively related to Things Always (.43), Suffixes (.38) and Theme (Novelty) (.41) Factor II was negatively related to Things Always (-.41), Suffixes (-.50) and Theme Fluency (-.73).

Manipulative Objects. The single Factor was significantly related only to Things Always (.38).

From these data it would appear that those Factors which define the creative space for Written Objects are related to some personality and cognitive traits of those who produce the objects; whereas Factors identified for Artistic and Manipulative Objects are related primarily to a select number of cognitive traits. Intercorrelations of all measures employed in the study were obtained and are shown in Appendices D, E and F.

Interpreting Dimensions of Creativity

The first phases of this study revealed the presence of three likely dimensions or factors associated with written products, two factors associated with artistic products, and a single factor associated with manipulative products of the sixth grade sample. And, that several personality and/or cognitive characteristics of the subjects were related to loadings on the identified factors.

Relationships of personality and cognitive characteristics to the factor loadings could provide some insight into the nature of the dimensions. To maximize the possible interpretation of the obtained factors, the final analyses of relationships were completed. In this instance, however, multiple regression techniques were employed rather than the series of zero order correlations previously reported.

Selection of Independent Variables.

Multiple regression techniques are used to indicate the relationship between two or more independent variables (predicators) and a dependent variable (criterion). As the number of predicator variables is increased it is expected that more variation in the criterion variable will be explained, i.e., the relationship will be greater and prediction of criterion behavior more accurate. The model is of such power that when the number of predictors is equal to the number of subjects upon which observations were made and the multiple correlation (R) will equal unity, i.e., prediction will be perfect. When there are more predictors than subjects, the regression solution is overdetermined.

In this study scores for 27 predictor variables were available for 25 subjects. Were all predictors to be used, the solution would be over-determined. A commonly used "rule of thumb" in regression studies is to limit the number of predictors to one half the number of subjects. Therefore, it was decided to employ 12 predictor variables for each retained factor.

Implementation of this decision necessitated a further strategy for predictor selection. The strategy selected was to select for each factor the 12 predictors which revealed the highest zero order relationship to the criterion measure (factor loadings) while at the same time exhibiting a minimum interpredictor relationship.

The strategy may be expressed

$$\sum_{i=1}^{12} r^2_{x_i, y} \longrightarrow \text{maximum}, \qquad \sum_{i=1}^{12} r^2_{x_i, x_i} \longrightarrow \text{minimum},$$

where x_i is an independent variable,
y is the criterion variable, and
r^2 is the squared zero order correlation.

Squared correlations were used to account for negative correlations and avoid a sum which approaches zero.

The 12 preditors identified for each factor are listed in Table 9.

Table 9

Predicator Selected for Regression Analyses

Factors

	Predicator Variable	Written			Artistic		Manipulative
		I	II	III	I	II	I
1.	Cyclothymia			X	X	X	X
2.	Mental Capacity		X	X		X	X
3.	Ego Strength				X		
4.	Excitability	X					X
5.	Dominance		X	X			
6.	Surgency	X		X		X	
7.	Super Ego Strength			X	X		X
8.	Parmia			X	X	X	
9.	Premsia	X	X	X	X		X
10.	Coasthenia		X	X			
11.	Shrewdness		X	X			
12.	Guilt Proneness		X	X			X
13.	Self Sentiment	X			X		
14.	Ergic Tension		X			X	
15.	CMAS						
16.	Things Always						
17.	Prefixes			X		X	X
18.	Suffixes		X	X	X	X	X
19.	Beginnings and Endings	x	x				
20.	Word Association (Fluency)	X			X		
21.	Word Association (Classes)						
22.	Uses (Fluency)	X		X	X	X	X
23.	Uses (Classes)	X	X			X	
24.	Ideas	X	X		X	X	
25.	Hidden Figures	X				X	X
26.	Theme (Fluency)	X			X		X
27.	Theme (Novelty)	X	X		X	X	X

Step-wise regression analyses were completed for each of the factors utilizing the factor loadings as criterion values and scores on those predictor variables identified for each factor shown in Table 9. The step-wise solution selects predictors one at a time on the basis of the amount of criterion variance explained. Initially the single predictor which accounts for most of his variance is selected. A "new" predictor is then selected which, in combination with previously identified predictors, maximizes criterion variance accounted for. The results of these analyses are reported below.

Written Objects

Factor I. The per cent of criterion variance accounted for by the 12 predictor variables is shown in Figure 9. Predictor numbers in the figure refer to those in Table 9.

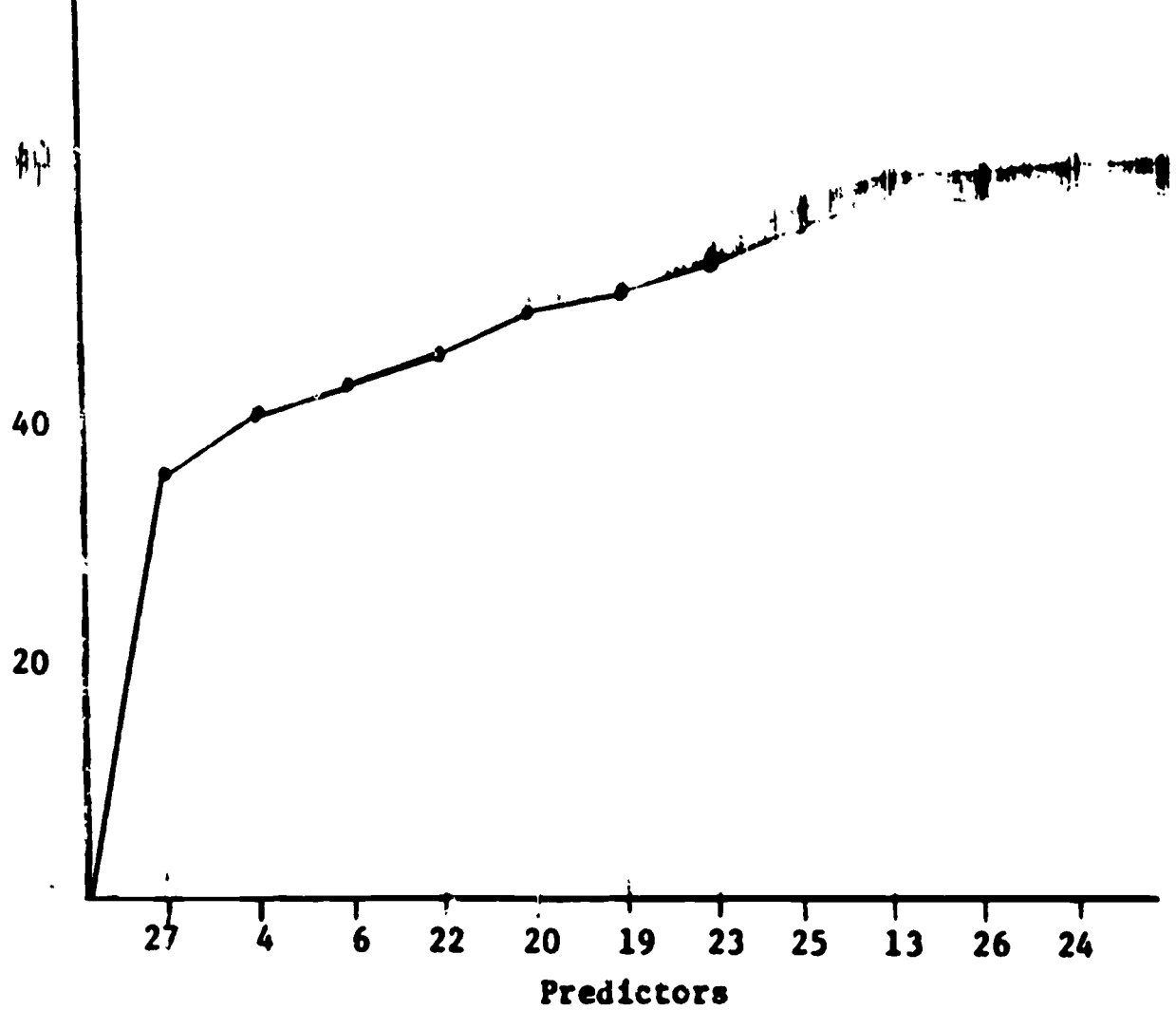

Figure 9. Per cent of variance in Factor F (written) Accounted for by Predictor variables.

These data reveal that loadings on this factor are primarily associated with novelty as measured by predictor #27. While relatively little additional criterion variance is accounted for by including the personality traits of Excitability and Surgency, their presence does provide an indication that persons who produce written products of this type may be described in terms of such traits.

Factor II. Per cent of criterion variance in this variable accounted for by the utilized predictor variables is shown in Figure 10.

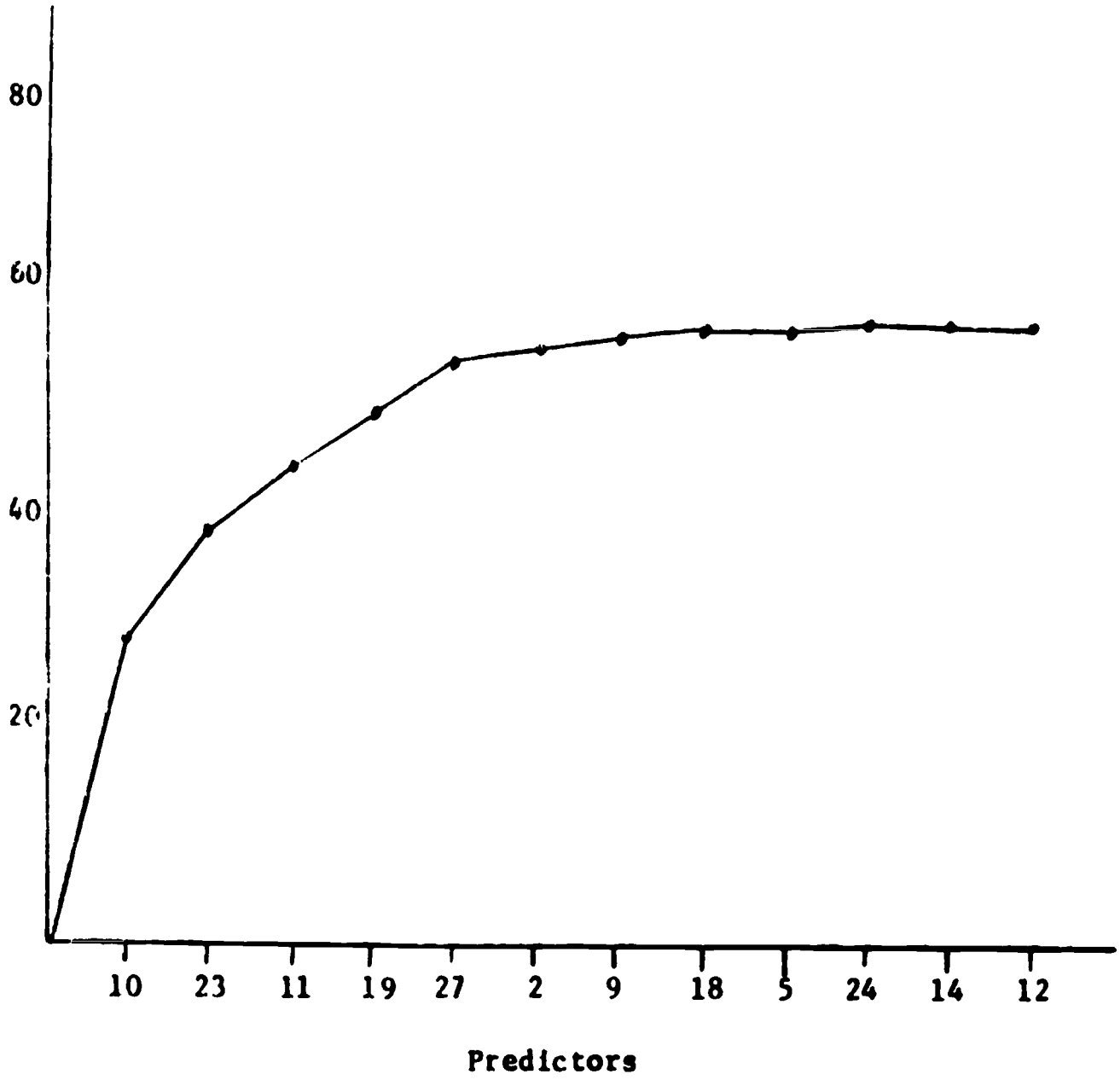

Figure 10. Per cent of variance in Factor II (written) Accounted for by Predictor variables.

Loadings on this factor were primarily related to scores on live variables. While Predictor #10, Coasthenia, was predominantly related, relatively high contributions were made by measures of ideational flexibility (Classes of uses, shrewdness, word fluency (Beginnings and Endings) and ideational novelty (Theme, novelty). The stories which loaded high on this factor tended to be produced by individuals who were self-sufficient, individualistic, and able to recombine words, and ideas in many ways. The factor is interpreted as being an indication of Flexibility.

Factor III. Per cent of variance in the loadings on this factor accounted for by the utilized predictor variables is shown in Figure 11.

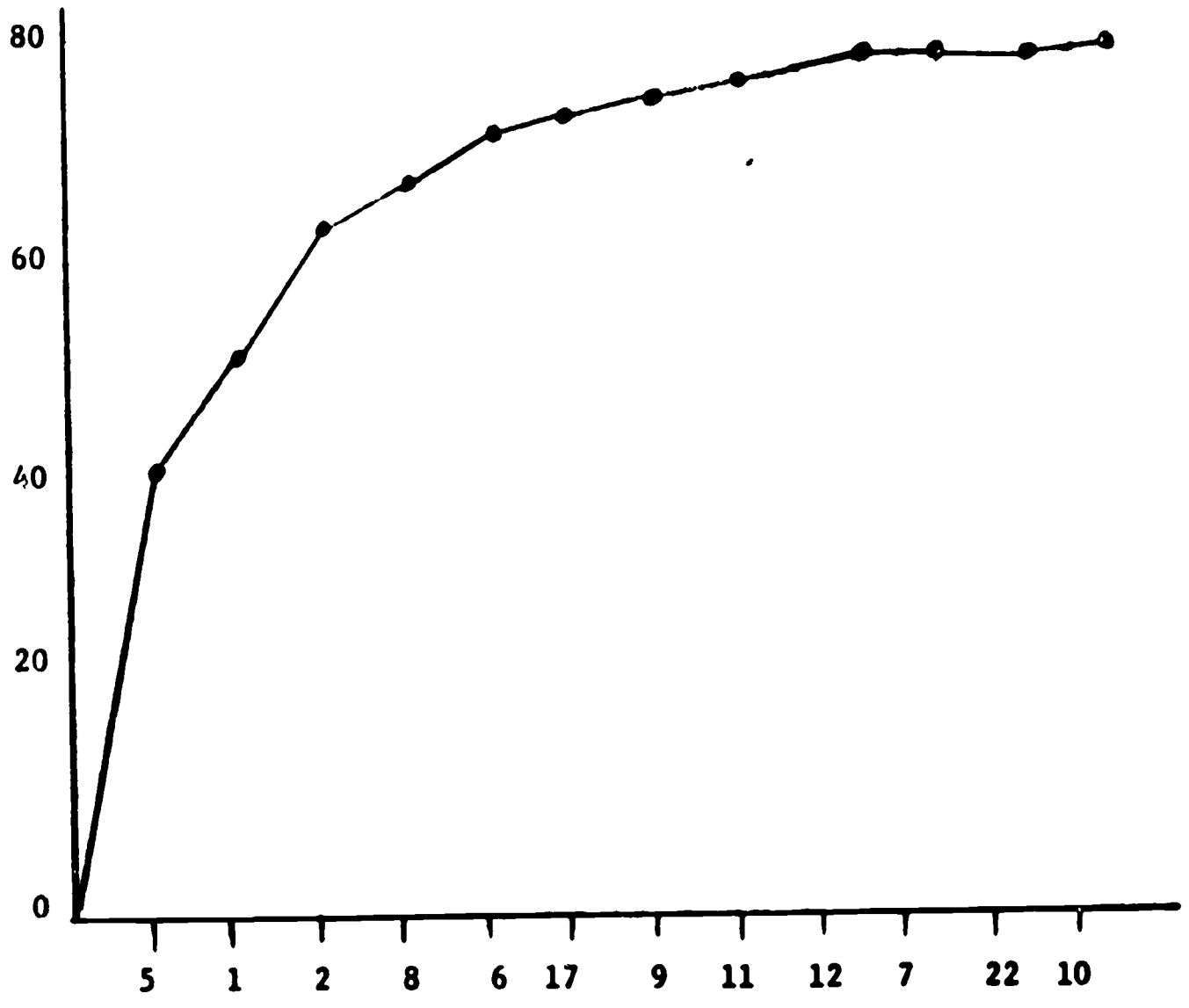

Figure 11. Per cent of variance in Factor III (written) Accounted for by Predictor variables.

This factor interiorated as being indicative of Openness to Expression. Stories loading high on this factor were produced by individuals who function on an affective plan, aware of their feelings. reactive to them and willing to express themselves in terms of their feelings.

From these data the three factors associated with creative writing are interpreted to be Novelty, Flexibility, and Openness to Expression. The dimensions are complementary and descriptive of elements of writing which would be judged as creative for children of this level of development.

Artistic Objects

Factor I. Per cent of variance in loadings on this factor accounted for by the utilized predictor variables is shown in Figure 12.

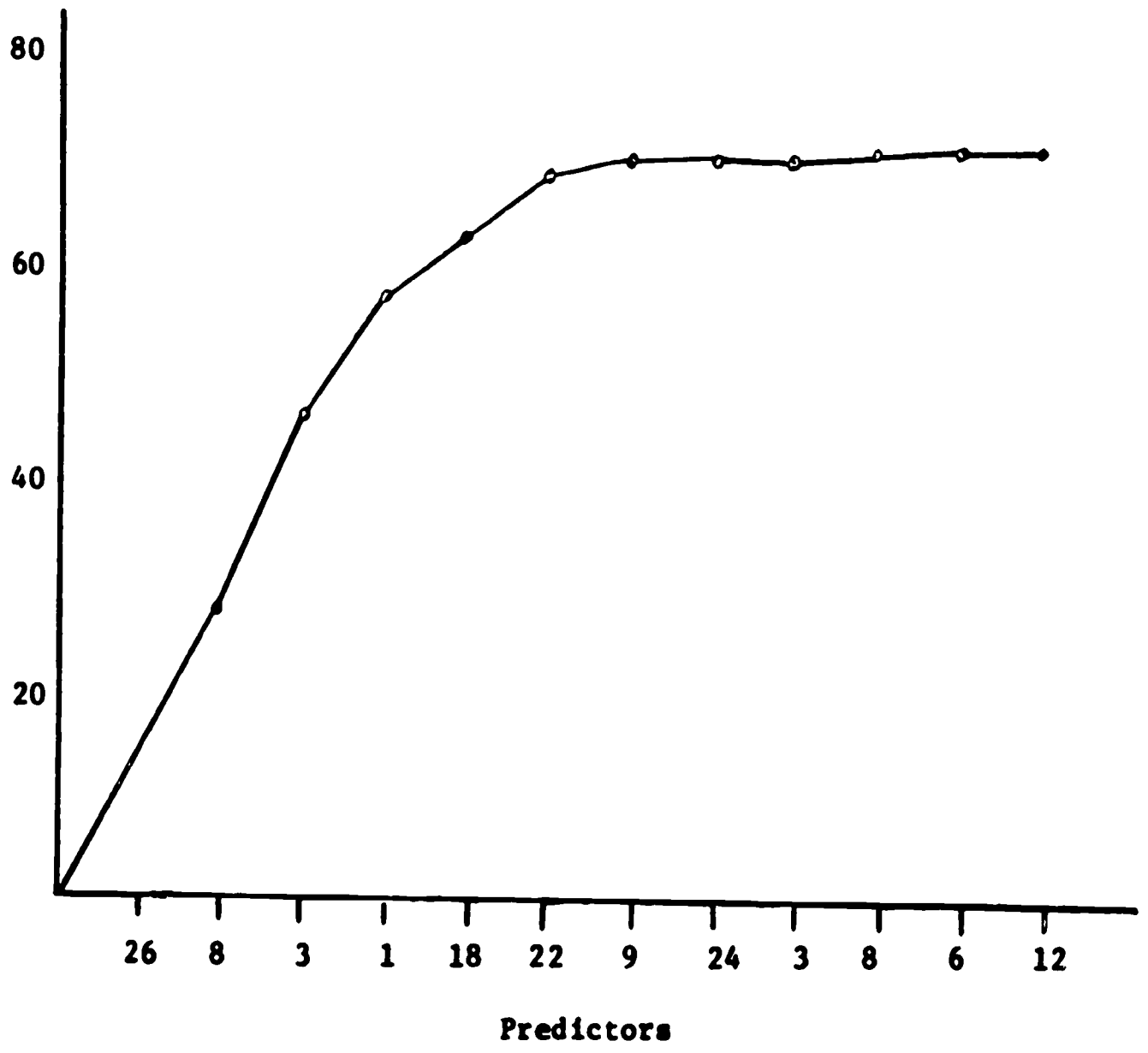

Figure 12. Per cent of Variance in Factor I (Artistic) Accounted for by Predictor Variables.

Variance in loading on this factor was primarily accounted for by scores on measures of ideational fluency (Predictor #26) and those personality traits descriptive of in creative individuals. In this instance it appeared that the distinguishing characteristic was the utilization of varieties of materials in the dioramas. The factor is interpreted as being a dimension characterized by Inventiveness.

Factor II. Per cent of variation in loading on this factor accounted for by the variance predictors is shown in Figure 13.

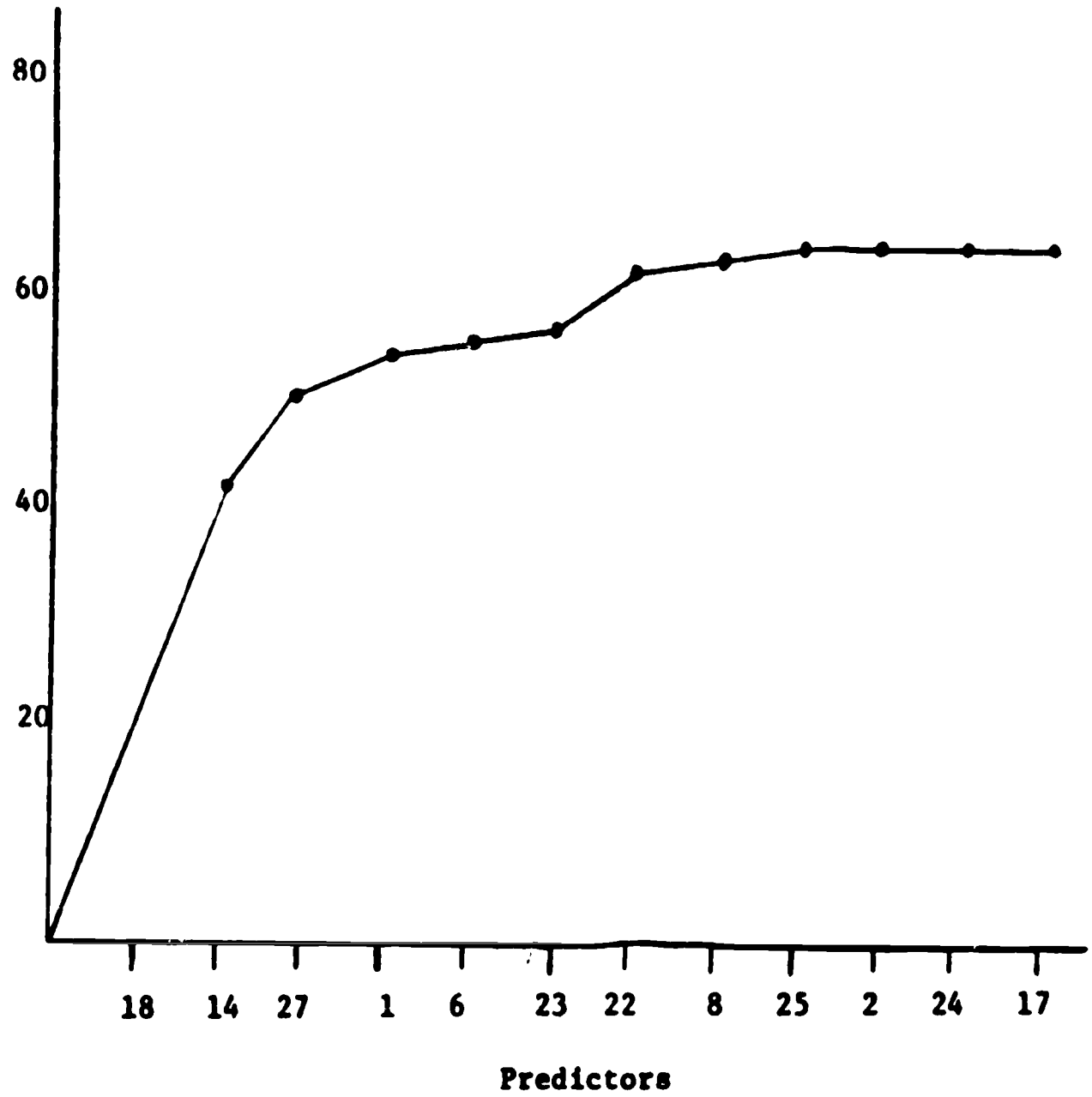

Figure 13. Per cent of Variance in Factor II (Artistic) Accounted for by Predictor Variables.

Variation in loadings on this factor were related primarily to observed scores on measures of word fluency (suffixes), Ergic Tension, and Ideational Novelty (Theme, Novelty). Objects which loaded high on this factor tended to be produced by individuals whose motivations were relatively unfulfilled, thus requiring an outlet which this medium likely provided, and who were able to introduce a variety and novelty into their release. The factor was labled as Motivated Novelty to differentiate it from the Novelty factor for written products.

For artistic products it appeared that creativity was a function of Inventiveness and Novelty as expressed by those who required this outlet for expression.

Manipulative Objects

Factor I. Per cent of variation in loadings on this factor accounted for by the utilized predictor variables is shown in Figure 14.

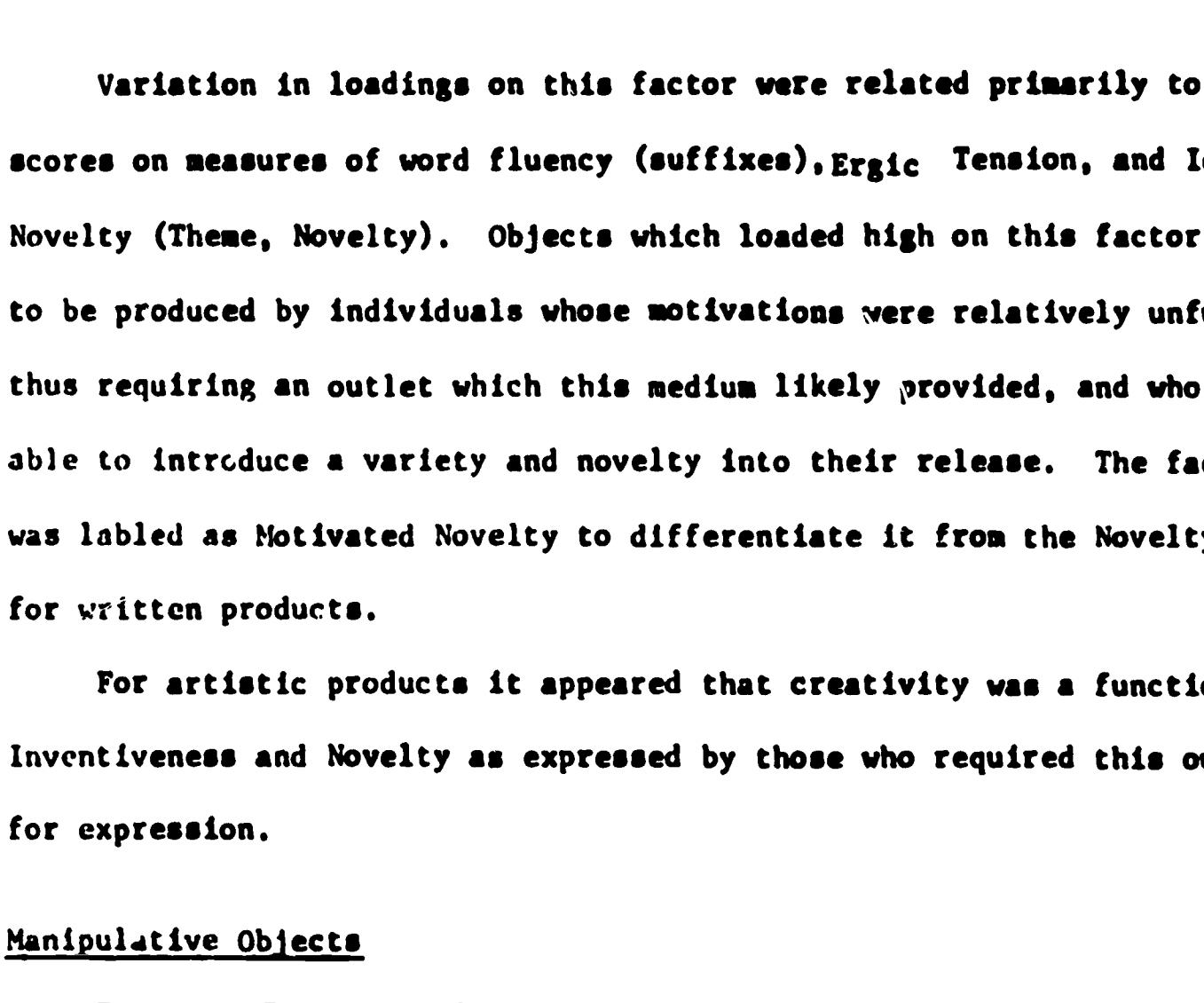

Figure 14. Per cent of Variance in Factor I (Manipulative) Accounted for by Predictor Variables.

Variation in the loadings on this factor is primarily related to scores on the Ideational Novelty (Themes, Novelty), self-adequacy (Guilt Proneness) and openness to feeling (Premsia) measures. Even so, the amount of variation explained was low, suggesting that the factor was only marginally related to any of the traits observed in this study. The factor is interpreted as representing Novelty.

This form of expression appeared to be inappropriately observed in this study. This is probably a function of the heavy reliance on motor dexterity required of subjects to complete the task in such a way that the finished product was reflection of the creative endeavor utilized.

Discussion

Several elements comprise the major focus of this study. One of these elements was concerned with the dimensionality of the concept under consideration, i.e., creative ability. The concern here stems from the fact that many of the studies in creativity to date have postulated that creativity behavior was multidimensional in nature but in the conduct of the studies the subject behavior (creativity) was dealt with as though it were a unidimensional trait. A second concern has been the fact that studies to date have attempted to find either cognitive or personality correlates with the subject behavior. And finally a third concern has been that study of creative behavior has all to often been limited to adult populations. This has been especially true when creativity is defined in terms of some products rather than in terms of some test-taking behavior.

In order to focus on the products of subjects in the study (sixth grade children) a relatively unused scaling technique was employed which permitted the creativity exhibited in the products to be viewed along more than a single dimension. This is to say instead of using a single criterion such as the rating of creativity of the products of the subjects along a single continuum, which is normally accomplished by asking which of these products exhibits more creativity than the other, this study attempted to identify the dimensionality required to define the behavior. The MDS procedure used permitted a maximum amount of freedom or lack of constraint in the judgmental behavior of the raters.

Subjects in the study were asked to produce three classes of products all of which were potentially possessing of some degree of creativity.

The classes of products were written, artistic, and manipulative. Ten judges graded the relative creativity of all objects prepared by the subjects within each class. The result of these judgments was the development of a judgmental space for each class which was then factor analyzed to determine the salient dimensions or factors of the creativity exhibited by the products. The resulting factor analysis within each class was rotated to simple structure utilizing varimax techniques described by Kaiser.

Whereas many studies in the past have focused only on cognitive or personality correlates with the criterion for creativity, this study revealed that neither class of correlates was, in itself, sufficient. of the factors interpreted, all contained both personality and cognitive correlated and in no case was it possible to identify any factor as being a solely cognitive or personality factor.

Written products were described by factors of Novelty, Flexibility, and Openness to Expression. The factors thus identified are consistent with previous studies to the extent that there appear to be elements of flexibility and originality needed to describe creativity within the written domain. However, these cognitive traits alone are not sufficient to give a complete picture of the trait. Added to this must the openness factor; the willingness to explore feelings and express them.

Within the art domain, as characterized by the production of dioramas by the sixth grade students, the factors again reflect originality in that the first factor could best be labeled one of inventiveness, and the second factor a function of Novelty, associated with high motivation for expression.

The manipulative domain, as characterized by the productions resulting

from use of the supplied kit, was characterized at best by Novelty, but was not adequately observed in this study.

It appears that each type of domain in which creativity may be expressed carries with it its own unique descriptors or predictors. It was apparent in the study that those individuals who produced creative stories had a set of characteristics distinct from those of persons who produced the more creative art objects which also were unique and distinct from those who produced the more creative manipulative objects.

The study should be considered as exploratory for certainly it contributes little more to the knowledge of creativity than the realization that a great deal of work must be done to test several distinct hypotheses.

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Appendix A
MDS Procedures

The MDS model employed in this study utilized the method of multidimensional rank order for collecting the judgmental imput data. These judgmental data were converted to interstimulus distances, where each stimulus was an object produced by one of the subjects. The process by which the conversion was completed consists of a series of matrix conversions. These conversions are outlined below beginning with the most basic matrix.

1. The ${}_kN_{ij}$ matrix. Rows i, columns j. Each cell contains the number of times stimulus i was judged more similar than stimulus j to stimulus k. The kth row and column are vacant.

2. The ${}_kP_{ij}$ matrix. Rows i, columns j. Each cell contains the proportion of times i was judged more similar than j to k.

3. The ${}_kX_{ij}$ matrix. Rows i, columns j. Each cell contains the unit normal deviate value associated with the proportion in the corresponding cell in the ${}_kP_{ij}$ matrix.

4. The ${}_kX._j$ matrix. Rows k, columns j. Each row contains the column averages of the corresponding ${}_kX_{ij}$ matrix.

5. The $.X._j$ matrix. This is a matrix with a single row. The cell entries are the averages of the columns of the ${}_kX._j$ matrix.

6. The G_{kj} matrix. Rows k, columns j. The cell entry in the gth row and hth column is $g_{gh} = (.^x.h + .^x._g)$.

7. The H matrix. Rows j, columns k. The element in each cell $h_{jk} = (g_{jk} + g_{kj})/2$.

8. The D matrix. Rows k, columns j, where the elements are $d_{jk} = h_{jk} + c$, where c is an additive constant.

9. The B* matrix. Rows k, columns j. The elements in the matrix are defined as

$$b^* = 1/2(1/n \sum_{j}^{n} d_{jk}^2 + 1/n \sum_{k}^{n} d_{jk}^2 - 1/n^2 \sum_{j}^{n} \sum_{k}^{n} d_{jk}^2 - d_{jk}^2)$$

The B* matrix was factored using the principal axis solution.

Appendix B

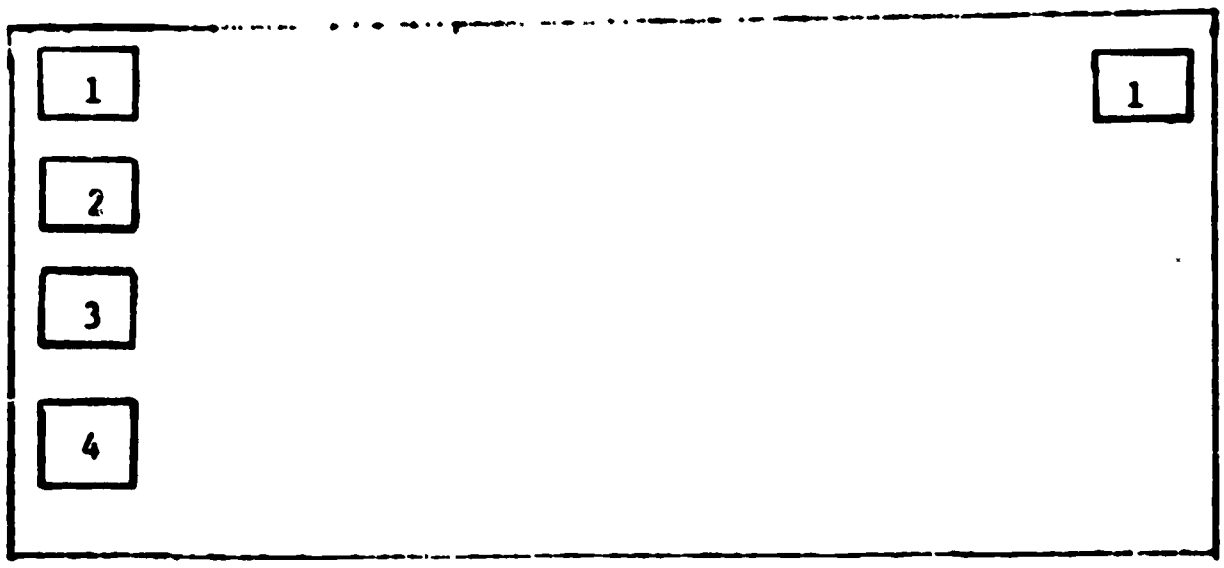
Directions for Making Judgments of Creativity

You have been given a kit containing necessary materials for making judgments of creativity. The kit contains

1. Three Recording Sheets,
2. A set of the 30 short stories written by students,
3. A set of 30 color photographs of the dioramas prepared by the students,
4. A set of 30 black and white photographs of the "devices" made by students, and
5. A copy of the students' own descriptions of the "devices" they prepared.

Your task is to indicate the <u>similarity</u> of the creativity exhibited by the products (stories, dioramas, and "devices"). The procedures for making your judgments of <u>similarity</u> for each type of product are the same; however, judge each type of product separately.

Below is an example. Some judge has indicated how similar the creativity exhibited by each of four "dioramas" (consider each box with a number in it to represent a picture of a diorama produced by a student) is to the diorama produced by Student #1.



The example indicates that the "judge" placed picture #1 in the upper right hand corner of his table. He then placed the other pictures on the table in the order of their similarity in exhibited creativity to that of picture #1. The "judge" felt that picture #2 exhibited creativity most similar to that of picture #1. He felt that picture #5 exhibited creativity next most similar to that of picture #1; picture #4 thirdmost; and picture #3 exhibited creativity least similar to that exhibited by picture #1.

After placing the pictures in the order that reflected his judgment of similarity in exhibited creativity, the judge indicated the ranking on the sample recording sheet below. Since picture #1 was the standard in this case, Dr. Brown (our judge) recorded all of his rankings in the first row (reading across). He placed a "1" in the box in column #2, indicating that creativity exhibited in picture #2 was most similar to that exhibited in picture #1. He placed a "2" in column #5, indicating that creativity exhibited in picture #5 was second most similar to that in picture #1.

Now you fill in the remaining boxes in that row according to the way the pictures were ordered by Dr. Brown.

Object: Dioramas

Judge: Joe Brown

	1	2	3	4	5
1	00	1			2
2		00			
3			00		
4				00	
5					00

You should have a "3" in column #4 and a "4" in column #3.

In the sample above, picture #1 is called the "standard" since all other pictures were ranked in terms of their similarity in exhibited

creativity to that of picture #1. If we were to complete the example, each picture would be used in turn as the standard and the ranking procedure repeated.

The Recording Sheets. Each recording sheet has a space at the top for indicating (1) the object being considered and your name. As you begin your judging write the name of the object (diorama, story, device) and your name in the appropriate space. You will note that each recording sheet has 30 rows (reading across) and 30 columns (reading down). The numbers of the rows and columns correspond to the number placed on the various objects. Use each row for recording your rankings of similarity when the "standard" number corresponds to the number of that row. For example, when object #5 is the standard, record your rankings of similarity to #5 in row #5.

Summary of Procedure.

1. Judgments of similarity in creativity should be made first for devices, next for stories, and finally for dioramas. Make all judgments for one before judging the next type of object.

2. Use each object of a given type, in turn, as the standard and follow the procedures outlined in the example.

3. Shuffle the pictures or stories after each ranking so that you will not be influenced by your previous rankings.

4. Work as quickly as you can.

5. Do not give any tie ranks.

6. Do not attempt to cross-check for consistency.

7. Record all rankings on the recording sheet. If you have any questions call me at Ext. 286, or at home, 757-1697.

Thank you,

James H. Beaird
Associate Research Professor

SUPPLEMENT TO: Directions for Making Judgments of Creativity.

One stimulus object (#26) has been deleted from the judging process. Therefore, the judges will have 29 instead of 30 of each item to rank. You will note that column 26 and row 26 have been marked out on the recording sheet. Your rankings will be from 00, 1, 2, 3,...28 for each stimulus object.

APPENDIX C

Description and Scoring Procedures Utilized for the Predictor Tests

1. IPAT - CHILDRENS' PERSONALITY QUESTIONNAIRE

This test is a downward extension of Cattell's 16 PF developed for adults. The test provides measures of 14 personality traits, all of which were utilized in this study. The traits are described in the test manual (Cattell and Porter, 1959). In this study the test was scored utilizing prepared scoring keys provided by the publishers.

2. HIDDEN FIGURES TEST

This test is an adaptation of the Gottschaldt Figures Test and was used to measure flexibility of closure. Flexibility of closure is defined as "the ability to keep one or more definite configurations in mind as to make identification in spite of perceptual distractions" (French, Ekstrom and Price, 1963). Scoring was accomplished through use of prepared keys provided by Educational Testing Service (ETS).

3. THEME TEST

The task required by this test is to write as much as possible about a given topic. The test was scored both for fluency and for novelty. The fluency score provides a measure of ideational fluency defined by French, Ekstrom and Price (1963) as "the facility to call up ideas wherein quantity and not quality of ideas is important!" The score is the length (number of words) of the theme. This test was also scored for novelty. Novelty scores were provided by assigning a value between 0 and 10 to the themes. Judges sorted the sample of responses first into two categories - novel and common. Resorting of each

category was made and scores of 0 to 5 were assigned to responses falling in the "common" class, and scores of 6-10 were assigned to responses in the novel class.

4. THINGS ALWAYS TEST

This test also provides a measure of ideational fluency. It requires the listing of as many objects as possible which are alike in a specified way (e.g. round or red). The score is the number of objects correctly listed.

5. SUFFIXES TEST

This test measures word fluency, "facility in producing isolated words that contain one or more structural, essentially phonetic restrictions, without reference to the meaning of the words" (French, et al., 1963). The task is to write as many words as possible ending with certain given letters and is scored by a count of the number written.

6. PREFIXES TEST

The task presented by this test is identical to that of the Suffixes Test except that the semantic constraint consists of initial letters of the words. The score is the number of words written.

7. BEGINNINGS AND ENDINGS TEST

Again this is a word fluency measure similar to the two just described. First and last letters of words are given and subjects asked to supply as many words as possible having been given initial and terminal letters. The score is the number of corrent words written.

8. WORD ASSOCIATION

The task is to write as many synonyms as possible for each of

two given words. This test is a measure of association fluency, the ability to produce words from within a restricted area of meaning. The score is the total number of correct synonyms produced.

9. ALTERNATE USES TEST

This test is commonly used as a criterion measure in studies of creativity. The test supplies the name of a common object and asks subjects to list as many uses as possible for the object. It may be scored for fluency (the number of uses listed) and for flexibility (the number of shifts made from one class of use to another). The latter score measures semantic spontaneous flexibility, the ability to produce a diversity of verbally expressed ideas in a relatively unrestricted situation. The former is a spontaneous fluency measure. Both scores are used in this study.

10. THE CHILDREN'S MANIFEST ANXIETY SCALE

This test consists of a series of statements of personal characteristics all of which describe an emotional reaction. Subjects check those statements which they feel describe them. The score is the number of statements checked. It is an adaptation of the Taylor Manifest Anxiety Scale and was validated by Palermo, et al. (1958).

APPENDIX D

Correlations of Personality and Cognitive Measures

Personality Measures	Cognitive Measures											
	16	17	18	19	20	21	22	23	24	25	26	27
1	.33	.37	.21	.02	.19	.17	.20	.14	.20	.01	.32	-.02
2	.46	.43	.33	.21	.53	.60	.55	.48	.35	.39	.43	.43
3	.38	.54	.19	.04	.38	.36	.44	.41	.14	.08	.05	.19
4	-.37	-.53	-.40	-.39	-.42	-.43	-.29	-.19	-.10	-.10	-.38	-.08
5	.01	.17	-.05	-.02	.06	.01	-.01	-.07	-.08	-.31	-.08	-.05
6	-.09	.06	-.09	-.20	-.13	-.18	.00	.03	-.22	-.21	-.28	-.23
7	.25	.04	.14	.07	.25	.19	-.02	-.10	-.02	-.01	.26	.13
8	.20	.29	.13	.13	.23	.20	.05	-.04	.09	-.21	.06	.03
9	.02	-.20	.07	.10	-.14	-.09	-.12	-.02	.12	.14	.20	.04
10	-.34	-.41	-.23	-.22	-.47	-.53	-.33	-.23	-.14	-.05	-.22	-.33
11	-.21	-.26	-.14	.00	-.23	-.17	-.26	-.24	-.00	-.04	.09	.10
12	-.47	-.31	-.45	-.17	-.48	-.42	-.36	-.36	-.02	.04	-.01	-.17
13	.46	.37	.57	.34	.45	.44	.32	.29	.20	.05	.31	.11
14	-.22	-.09	-.16	-.14	-.23	-.19	-.08	.02	.12	.16	-.04	-.12
15	-.42	-.31	-.57	-.48	-.49	-.54	-.32	-.27	.10	.12	-.25	-.12

APPENDIX E

Intercorrelations of Personality Measures

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1		.19	.32	-.03	.05	-.02	.46	.24	-.04	.50	.11	.31	.42	.32	
2			.48	-.28	-.03	-.13	.22	.30	-.10	-.66	-.18	.44	.20	.03	
3				-.19	.07	.61	.14	.49	-.52	-.55	.10	.73	.15	-.30	
4					.04	.20	-.56	.47	-.13	.51	.39	.34	-.77	.65	
5						.72	-.05	.70	-.71	.31	.08	-.46	-.08	-.30	
6							-.00	.48	-.56	.02	.02	-.44	-.26	.06	
7								.14	.10	.33	-.31	-.33	.54	.39	
8									-.44	.41	-.13	-.53	.28	-.63	
9										.31	-.05	.36	.21	.19	
10											.09	.57	-.46	.61	
11												.29	-.40	.17	
12													.45	.48	
13														-.49	
14															
15															

APPENDIX F

Intercorrelations of Cognitive Measures

	1	2	3	4	5	6	7	8	9	10	11	12
1		.71	.80	.33	.66	.65	.47	.42	.52	.46	.63	.45
2			.52	.12	.45	.53	.51	.47	.41	.44	.45	.19
3				.48	.54	.59	.50	.46	.26	.21	.50	.20
4					.68	.77	.30	.27	.17	.15	.33	.28
5						.93	.67	.59	.22	.44	.41	.40
6							.63	.56	.25	.39	.45	.50
7								.96	.09	.42	.28	.17
8									.04	.47	.19	.09
9										.30	.45	.42
10											.41	.19
11												.40
12												